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THIRUNELVELY, JAFFNA,

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Message from the Vice-Chancellor

I am very pleased indeed to send this message on the occasion of the publication of the first issue of *Vingnanam*, a most praiseworthy effort on the part of the Faculty of Science.

The Faculty of Science in the University of Jaffna, since its inception, has made a notable contribution - through its teaching and research work - to science education in this country. The decision to publish a research journal by this Faculty is yet another landmark in its development.

Vingnanam provides a forum for staff and research students to publish their research findings and thereby fulfils a long - felt need.

I am also happy to note that some of the papers published in this issue reflect the involvement of the Faculty in areas of research with a regional focus– which I consider to be a most desirable aspect.

I am confident that *Vingnanam*, embodying the best traditions of scientific inquiry, will be a welcome addition to scientific literature.

The Editorial Board has done an excellent job in bringing out the first issue in the midst of highly disturbed conditions in the region.

I extend my wholehearted support to *Vingnanam* and wish it success in the years ahead as well.

Professor S. Vithianathan
Vice - Chancellor

FOREWORD

It is universally accepted that scientific research and the application of scientific knowledge to the solution of local problems are essential for the development of a country. The Universities are expected to play a key role in these activities and in the dissemination of new knowledge acquired through research. Yet, in Sri Lanka, due to various constraints such as the brain drain arising from poor salaries and service conditions of University Teachers, inadequate research facilities and the absence of an atmosphere conducive to research, the Science Faculties in the Universities have not been able to make an effective contribution to national development through research.

The shortage of qualified staff arising from the brain drain results in an increase in the work load of those teachers who opt to stay behind and serve the country and prevents them from devoting much time to research. It also hinders the formation of effective and viable research groups. Often, the research activity in a University is a lone effort by committed individuals. Even in such cases, the results of work done painstakingly over several years sometimes remain unpublished and inaccessible to other workers due to the non-availability of journals which would be willing to accept the publication of results that may be considered to be of local interest only. It is in this context that the Faculty of Science, University of Jaffna, conceived the idea of publishing a science journal to enable teachers and postgraduate students in the University to publish the findings of their research as quickly as possible. It is hoped that the publication of the journal will generate more research in the Faculty and increase the scientific tempo in the University. Although the journal is intended primarily as a medium for communicating the results of research done by teachers and students of this University, research articles of local and general interest and review articles of topical interest from other Universities and research institutions, both local and foreign, will also be welcome.

The year 1986 was one of great turmoil in Jaffna. As a result, only one issue of the journal has been brought out instead of the planned two. Even that has been made possible only due to the dedication and hard work of the Editorial Staff. I congratulate them on a job well done.

Professor K. Kunaratnam
Dean, Faculty of Science

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Research contribution from the Universities in many developing countries has not been comparable to that from the developed countries. This is attributed mainly to heavy teaching load and inadequate facilities for research, besides other factors. These shortcomings have been recognized and attempts are now being made to encourage Universities to promote academic research.

Furthermore, exhorbitant fees levied for postgraduate courses in the Universities of the West and the limited Scholarship or Assistantship awards available for postgraduate courses in these Universities have made it imperative for Universities in Sri Lanka to initiate graduate courses wherever possible Hence it is expected that research contributions from our Universities will increase. These should be efficiently communicated locally, not only for promoting practical application of research findings but also for identifying problems that need investigation by the national Universities.

Vingnanam - Journal of Science is conceived at this time as a journal that would help disseminate worthwhile research contributions from Sri Lankan Universities and other research organisations, both nationally and internationally. A journal with a wide circulation within Sri Lanka would also help to improve coordination of research. It is hoped that *Vingnanam* would achieve these objectives.

In this first issue, eight out of the nine articles published deal with subjects directly concerned with national problems.

K. Theivendirarajah and R. Kumuthini Chrystopher have presented two papers on alcohol produced from palmyrah palm sap and fruit pulp — a major economic product of this least investigated palm of the tropics. S. Kandiah and S. Mahendran have communicated the early results of their investigation on propagation techniques for palmyrah palm, a subject of much importance to the Palmyrah Development Board of Sri Lanka.

The two papers by G. F. Rajendram with Daphne J. E. Daniel and Francesca R. Devarajah describe the biology of a rice pest and its predator in Sri Lanka. The information should be useful in designing control measures. Canker disease of lime (Citrus) and fruit rot disease of brinjal (*Solanum*), two topical problems of farmers in Sri Lanka, are subjects of two papers by Sothisorubini Nalliah *et al.* and R V. S. Sundaresan *et al.* respectively.

Chelliah Elankumaran has provided very important evidence for the increasing salinity trend in the ground water that sustains the population of the Jaffna peninsula. This paper should stimulate further research on this crucial water resource problem of the North.

"The Frame Factor — An approach to Special Relativity" by M. R. R. Hoole is an article that would be of interest to relativists among the physical scientists.

Miss C. D. Jeevaraj assisted me in designing the cover and other members of the staff of the Botany Department ungrudgingly helped in the compilation of this issue. I thank all of them on behalf of the Editorial Board.

EDITOR

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CONTENTS

CHEMICAL ANALYSIS OF PALMYRAH PALM *BORASSUS FLABELLIFER* L. WINE ('TODDY')

K. THEIVENDIRARAJAH AND R. KUMUTHINI CHRYSTOPHER
(Department of Botany, University of Jaffna, Jaffna, Sri Lanka)

Vingnanam — Journal of Science 1 : 1—7 (1986)

ABSTRACT The palmyrah palm, *Borassus flabellifer* L. wine ('toddy'), is the spontaneously fermented sap obtained from male and female palmyrah inflorescences by a process known as 'tapping'. In the unfermented state, this sap contains 10-16% w/v sugar, mainly in the form of sucrose. After complete fermentation, this toddy has an average v/v alcohol content of 5.8% and a pH of about 3.9. The acid produced during this natural fermentation process was found to be mainly acetic acid. The acidity of a fully fermented toddy is 0.5% (w/v). Ascorbic acid (vitamin C) content of palmyrah toddy was found to be 39.58 mg/l. The analysis of toddy distillates by gas liquid chromatography revealed that the major product of this fermentation is ethanol with varying amounts of methanol, n-propanol, isobutanol, ethyl-acetate and n-amyl alcohol. The last three compounds, mainly the ester ethyl acetate, were present in all the samples analysed thus suggesting that the presence of these compounds could be the cause of the characteristic aroma of palmyrah toddy distillates.

Introduction

The palmyrah palm, *Borassus flabellifer* L. wine ('toddy') is a mild alcoholic beverage of Northern Sri Lanka and other palmyrah growing countries. It is the spontaneously fermented sap of the inflorescences of both male and female palmyrah.

In fact, the main product of the palmyrah palm is the sap extracted from the inflorescences by a process known as 'tapping'. The term 'tapping' collectively denotes the artificial extraction and the various processes of stimulating the different sap yielding palms to exude juice from a selected part, for example, the inflorescences of the palmyrah and coconut palms. The tapping of the palmyrah palm for its sap is done mostly in India, Thailand and Sri Lanka where there are heavy concentrations of palmyrah. The method of tapping the palmyrah palm varies with the sex of the palm and the age of the inflorescence (Thirukanesan and Theivendirarajah, 1978). The sap obtained from the inflorescences of the palmyrah palm is consumed either in an unfermented state (sweet toddy/neera/pathaneer) or in a fermented state (toddy/wine) or it may be consumed in some processed form such as jaggery.

From the analytical data presented by Mohanadas (1974), it is evident that the palmyrah sweet toddy is rich in nutrients and therefore can be used as a balanced nutrient medium for the growth of yeasts and bacteria. Hence it enables the spontaneous and quick fermentation of sap by the yeasts from the air.

Unfermented fresh palmyrah sap contains 10-16.5%(w/v) sugar, mainly in the form of sucrose with varying amounts of glucose and fructose depending on the degree of fermentation (Chrystopher, 1985). Due to the action of wild yeasts and bacteria, this sugary sap, which has a neutral pH, is fermented to produce palmyrah toddy, which usually contains 5-6% (v/v) ethanol and has a pH of about 3.9 after complete fermentation (Theivendirarajah and Chrystopher, 1983). This indicates that certain acids are produced during the course of fermentation process or after the completion of ethanol production. These acids may be produced as a result of microbial activity. Palmyrah toddy, when brought down from the palm, is very sweet and refreshing. But it becomes sour and unpleasant after 10-12 hours. This may be due to the formation of acids in the toddy samples. However, Cowap and Geake (1932) suggest that even though more acids are formed during the storage period of toddy samples, the acidity of toddy cannot safely be regarded as a criterion of its age.

Alcoholic beverages appeal to man for many reasons. Among these are physiological effects, the appeal to the eye because of the clarity and colours, the pleasent tastes and the aroma and bouquet which are perceived through the sense of smell. In general, the aroma of alcoholic beverages is not due to single 'impact' flavour compound, but to a complex mixture of compounds (Webb and Muller, 1972).

The sugar, alcohol and vitamin C contents of fully fermented palmyrah toddy were estimated, and the acids found in palmyrah toddy were identified. The aroma compounds of palmyrah toddy were also analysed.

Materials and Methods

The total sugar content of completely fermented palmyrah toddy was determined by the Somogyi's semimicro method and its vitamin C content by the indophenol dye reduction method (AOAC, 1960). The mean alcohol content of these toddy samples was determined using an ebulliometer and the acidity by titration.

The identification of the acids produced during this natural fermentation process was done according to the method described by Randerath (1968). Silica gel plates of 300 μm thickness were prepared, activated and then spotted with palmyrah toddy samples. Authentic samples of lactic and acetic acids were spotted as standards. The chromatogram was developed in a 1:2 (v/v) mixture of pyridine and petroleum ether. The developed plates were then sprayed with the reagent bromocresol purple and the Rf values were calculated.

Analysis of aroma compounds

Naturally fermented palmyrah toddy samples and samples obtained by fermenting palmyrah palm sap under different experimental conditions were distilled and distillates analysed on a Varian 2440 gas chromatograph using operational parameters given below:

Packing material : Poropak Q 1.5 m × 3 mm
Operating condition : 80°C - 180°C
Carrier gas flow: Helium, 30 ml / min.

Results and Discussion

The alcohol, sugar, vitamin C and acid contents of palmyrah toddy after complete fermentation are given in Table 1. It is obvious that most of the sugar in the sap is converted into alcohol due to the action of wild yeasts and bacteria in the sample. The estimation of the ascorbic acid (vitamin C) content of palmyrah toddy in the present paper (39.58 mg/l) agrees with that reported by Sambandham[2] but is considerably less than that reported by Paulas and Muthukrishnan[3], who have estimated a value of 132.5 mg/l. However, both these studies show that there is an appreciable amount of vitamin C in palmyrah toddy.

Table 1. Alcohol, sugar, vitamin C and acid content of completely fermented (48h) palmyrah toddy

	Average content
Alcohol (ethanol) %v/v	5.8
Sugar %w/v	less than 1.0
Vitamin C mg/l.**	39.58
Acid (as acetic acid) %w/v	0.5

** Only Vitamin C present in the form of L-ascorbic acid was estimated

Besides alcohol, acetic acid, vitamin C and residual sugar, palmyrah toddy also contains varying amounts of yeast and bacterial cells, usually in the region of 10^8 cells/ml. The types of yeasts and bacteria present in naturally fermented palmyrah toddy have already been identified (Theivendirarajah and Chrystopher, 1984; Chrystopher, 1985).

The acid separated on the chromatogram had an Rf value of 0.58 corresponding with that of acetic acid. This shows that the major acid produced during the natural fermentation of palmyrah sap is acetic acid, due to the presence of which, the fully fermented palmyrah toddy is sour and has a somewhat bitter taste. This acid may be produced as a result of yeast metabolism or by bacterial oxidation of ethyl alcohol produced by the fermentation of sugars by wild yeasts.

2 Sambandham, K. (1983). Neera - the Nectar, Workshop on Palmyrah - organized by the Food & Agricultural Organization and Palmyrah Development Board, Jaffna, Sri Lanka.

3 Paulas, D & Muthukrishnan, C. R. (1983) The situation of palmyrah in India. Workshop on Palmyrah - organized by the Food & Agricultural Organization and Palmyrah Development Board, Jaffna, Sri Lanka.

Analysis of toddy distillates by gas-liquid chromatography reveals that the major product of palmyrah sap fermentation is ethanol with varying amounts of methanol, n-propanol, isobutanol, ethyl acetate and n-amyl alcohol (Fig. 1). The ester ethyl acetate was present in all the samples analysed, suggesting that this compound may be the cause of the characteristic aroma of palmyrah toddy distillates, which are commonly referred to as 'palmyrah arrack'. Table 2 gives the major components of the distillates obtained under different conditions.

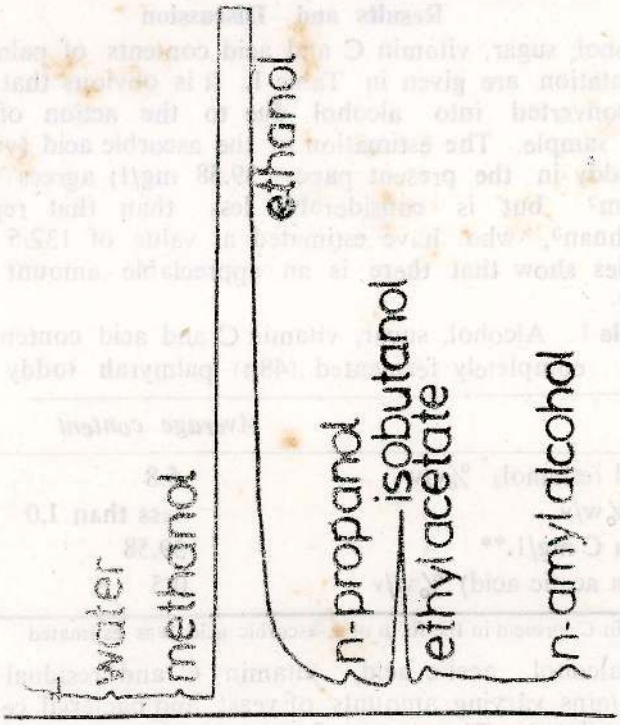

Fig. 1 Gas-liquid chromatogram of distillate of toddy obtained from young female inflorescences of palmyrah palm (sample Number 3).

Table 2. Analysis of palmyrah toddy distillates

*Compound / * Sample no.*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Methanol	tr	+	+	+	tr	+	+
Ethanol	+	+	+	+	+	+	+
n-propanol	tr	tr	+	tr	+	tr	+
Isobutanol	tr	+	+	+	+	+	+
Ethyl acetate	+	+	+	+	+	+	+
n-amyl alcohol	+	+	+	+	+	+	+

tr = traces

* sample no. — Description

1 — Distillates of toddy obtained from young male inflorescences of palmyrah palm

2 — Distillates of toddy obtained from matured male inflorescences of palmyrah palm

3 — Distillates of toddy obtainded from young female inflorescences of palmyrah palm

4 — Distillates obtained from non-heat sterilized palmyrah sweet toddy medium fermented with *Saccharomyces cerevisiae*

5 — Distillates obtained from non-heat sterilized palmyrah sweet toddy medium enriched with salts and fermented with *Saccharomyces cerevisiae*

6 — Distillates obtained from heat sterilized palmyrah sweet toddy medium fermented with *Saccharomyces cerevisiae*

7 — Similar to sample 6, but fermented with *Saccharomyces chevalieri*

The mixture of compounds found in arrack other than ethanol is collectively denoted as 'fusel oil'. The differences in fusel oil content of the toddy distillates obtained from young and mature male inflorescences may be due to the different microflora found in these samples. Rankine (1967) reported that the amounts of the higher alcohols formed were not related to the amount of sugar consumed during the fermentation process; hence the differences in the sugar content of these saps will not be the cause of the variation in fusel oil content.

It was found that sterilization of the palmyrah sweet toddy medium prior to fermentation by the yeast *Saccharomyces cerevisiae* (previously isolated from palmyrah toddy) reduces the fusel oil content of the sample. This may be due to the absence of wild yeast and bacterial strains in heat-sterilized palmyrah sweet toddy medium. However, addition of salts such as NH_4Cl, $MgSO_4$ and KH_2PO_4 to the non-heat sterilized medium prior to fermentation by the same yeast strain seems not only to reduce the amount of fusel oil in the distillate but also to increase the amount of ethanol in the sample. Most probably these salts may induce the growth of the inoculated yeast strain which may overgrow the wild yeast strains; the wild yeast strains are thought to be the cause of higher fusel oil production in toddy samples. Amerine *et al.* (1972) also reported that the addition of ammonium phosphate prior to fermentation, reduces the production of higher alcohols.

From the results presented, it is apparent that the compositional variation between distillates may be due to differences in the toddy samples or the maturation period employed. It is found that there are no differences in the

fermentation patterns of the yeasts belonging to the same genus i.e. *Saccharomyces cerevisiae* and *Saccharomyces chevalieri* (both previously isolated from palmyrah toddy). However, as Rankine (1967) and Jeganathan (1981) suggest the characters of arrack could be altered by selecting the yeast combination for fermentation and variation may be found in the fermentation patterns of yeasts belonging to different genera.

The nitrogen content of yeasts also affects fermentation and formation of fusel oil (Jha, 1972). The production of fusel oil increases when the yeast has feeble fermenting power and is poor in cell nitrogen. Therefore, the addition of a high inoculum of yeast, rich in nitrogen, will reduce the formation of fusel oil.

Rajendrasingh and Kunkee (1976) suggest that there is a close relationship between the control of activities of alcohol dehydrogenase and formation of fusel oil alcohols. As different yeast strains may have different alcohol dehydrogenase activities, the amount of fusel oil produced by yeasts belonging to different genera will vary.

In addition to the strain of yeast and composition of the palm sap, the production of higher alcohols is influenced by conditions of fermentation and distillation. Volatile acids, esters, aldehydes and fusel oil alcohols are produced mainly during fermentation. Acids and fusel oil alcohols distil over with the 'tailings' whereas esters and aldehydes distil over with the 'foreshots'. Esters and aldehydes can be formed even during the process of distillation. Therefore, these 'foreshots' and 'tailings' are usually discarded during the preperation of high quality arrack.

The presence of ethyl acetate in all the samples analysed supports the earlier conclusion that acetic acid is the major acid produced during fermentation of palmyrah sap. The origin of the ester ethyl acetate is almost certainly microbiological.

Although most of these byproducts of alcoholic fermentation are very poisonous if separated out by themselves and given in sufficiently large amounts, in the proportions in which they are usually found in arrack (traces), their action is quite harmless.

Acknowledgement

The authors thank the Director, CISIR, Colombo for arranging for the use of Varian 2440 gas chromatograph.

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OBSERVATIONS ON THE BIOLOGY OF *NILAPARAVATA LUGENS* (HOMOPTERA : DELPHACIDAE)

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Vingnanam — Journal of Science 1 : 8—13 (1986)

ABSTRACT Studies were carried out on the biology of *Nilaparvata lugens* (Stal) cultured on rice variety TN 1. Eggs were 0.84 mm long and 0.16 mm wide; macropterous adult male 2.9 mm long and 1.1 mm wide; female 3.3 mm long and 1.2mm wide; brachypterous adult male 2.9mm long and 1.0 mm wide; female 3.7 mm long and 1.1 mm wide. Mean incubation period of eggs was 9.6 days; longevity of macropterous adult male was 13.2 days, female 16.4 days; brachypterous adult male 11.2 days and female 11.6 days. These values are compared with results obtained from studies in Japan and Philippines.

Introduction

The brown planthopper *Nilaparvata lugens* (Stål) is one of the most destructive pests of the rice crop in Southeast Asia. It damages the plant directly through feeding on it and also by transmitting the virus diseases "grassy stunt" (Ling, 1972) and "ragged stunt" (IRRI, 1978). Heavy infestation causes drying up of the plant—a condition known as "hopperburn" (Dyck & Thomas, 1979).

In Sri Lanka, *N. lugens* was first recorded as a pest in Kalutara district in 1912 (Fernando *et al.*, 1979). Since then sporadic outbreaks have occurred in several areas, mainly in southwestern Sri Lanka. In the last three decades the brown planthopper has been appearing in large numbers in several districts, especially Amparai and Batticaloa, occasionally causing hopperburn (Fernando, 1975; Rajendram, 1982).

Studies on the biology of this pest have been carried out in Japan by Harukawa (1951), Kuwahara (1956), Suenaga (1963) and Mochida (1964) and in the Philippines by Bae & Pathak (1970).

The present paper describes the results of laboratory studies on the biology of *N. lugens*, including morphometrics, longevity and fecundity.

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Materials and Methods

Cultures of *N. lugens* were obtained from rice fields in Amparai district and mass cultured in the laboratory at the University of Peradeniya on rice variety TN 1, grown in 25×15×9 cm wooden boxes, kept in 30×25×25 cm fine mesh cages with plastic doors. The temperature in the laboratory registered a range of 25 - 29.5° C and relative humidity 30 - 100%. Pairs of adult *N. lugens* were reared in 15×1·5 cm test tubes into which a 12 day old rice seedling was introduced and held in place by moist cotton. The mouth of the test tube was plugged with cotton. Unless otherwise indicated, a total of 50 observations, spanning 5 generations, comprising 10 observations per each generation, were made.

Eggs were obtained by maintaing pairs of *N. lugens* adults in test tubes for 24 hours. The rice stems were then removed and dissected under a stereo-microscope in order to locate the eggs, which were then measured with the help of an ocular micrometer.

To study the incubation period, the egg bearing sections of the rice stems were nipped off and transferred into 7.5×2.5 cm glass vials and placed on 7×2.5 cm strips of filter paper, moistened with tap water. A few leaf blades of the rice plant, 6 - 7 cm long were also introduced into the vials to serve as food for nymphs on emergence. Observations were made daily for 15 days after oviposition to determine the number of nymphs hatching out daily, and the average incubation period calculated. At the end of 15 days, the stems were dissected out to determine eggs unhatched.

Studies on nymph size and duration were made by transferring newly emerged nymphs from the previous experiment, by means of an aspirator, to individual test tubes. The nymphs were transferred to test tubes with fresh plants every 4 days during the early stages and every 3 days after the fifth instar stage. The duration of each instar was noted and the body length measured on the day of moulting.

Measurement of body length of adults was made on the day of emergence from the fifth instar. The body length up to the tip of the abdomen was measured.

Longevity studies were carried out on newly emerged adults reared in pairs in test tubes. The adults were transferred to test tubes. with fresh seedlings every 2 days.

Fecundity studies were also made on pairs of newly emerged adults reared in test tubes. These were transferred to a test tube with a fresh plant every 2 days. Observations were made daily for a period of 10 days. The oviposited stem was

transferred to a 7×2.5 cm vial and placed on moist filter paper. The number of nymphs emerging from each vial was counted. Fifteen days after oviposition the stem was dissected and the number of unhatched eggs counted.

When two values were compared, t-test was employed to determine significance; when more than two values were compared, analysis of variance was employed. Significant contrasts were determined by means of studentized range q tests.

Results and Discussion

The dimensions of eggs, nymphs and adults are presented in Table 1. Females of both macropterous and brachypterous forms had significantly longer body lengths than the respective males.

Table 1 Dimensions of *N. lugens* Egg, Nymph and Adult cultured on rice variety TN 1

Developmental Stage		*Number of individuals*	*Length (mm) (Mean±SD)*	*Width (mm) (Mean±SD)*
Egg		50	0.84±0.06	0.16±0.02
Nymph :	1st instar	50	0.70±0·07	0.24±0.03
	2nd instar	50	1.00±0.07	0.42±0.03
	3rd instar	50	1.40±0.14	0.60±0.05
	4th instar	50	1.90±0.12	0·85±0·06
	5th instar	50	2.40±0.10	0.92±0.05
Adult :	Macropterous			
	Male	50	2.90±0.15	1.1±0.07
	Female	50	3.30±0.14	1.2±0.05
	Brachypterous			
	Male	50	2.90±0.15	1.0±0.03
	Female	50	3.70±0.27	1.1±0.04

The incubation period of eggs and developmental period of nymphal instars are given in Table 2. The mean incubation period of 9.6 days is in general agreement with the values of 7.3 to 10.5 days, under temperature range of 23.7° to 25.6°C, reported from Japan (Harukawa, 1951). It is longer than the average of 7.3 days, under a temperature range of 19° to 33°C, recorded in the Philippines (Bae & Pathak, 1970).

Table 2 Developmental Period of *N. lugens* Egg and Nymph cultured on rice variety TN 1

Developmental Stage		*Number of individuals*	*Range (days)*	*Duration (days) (Mean±SD)*
Egg		920	9 - 10	9.6±2.30
Nymph:	1st inster	50	3 - 4	3.4±0.49
	2nd inster	50	2 - 4	2.8±0.69
	3rd inster	50	2 - 4	2.8±0.64
	4th inster	50	2 - 4	2.5±0.57
	5th inster	50	2 - 5	4.0±0.54

Longevity of adults (Table 3) did not differ significantly between males and females in both macropterous and brachypterous populations. Longevity of 13.2 days for macropterous males and 16.4 days for macropterous females are in general agreement with 12.8 days and 17.8 days respectively reported for *N. lugens* cultured on IR 9 - 60 in the Philippines (Bae & Pathak, 1970).

Table 3 Longevity of *N. lugens* Adult cultured on rice variety TN 1

N. lugens Adult	*Number of individuals*	*Range (days)*	*Duration (days) (Mean±SD)*	*F-value*
Macropterous				
Male	20	5 - 32	13 2±4.9	
Female	20	6 - 30	16.4±5·9	
Brachypterous				
Male	20	7 - 15	11.2±3.2	
Female	20	2 - 22	11.6±4.0	1.8*

* Not significant at 5% level.

Mean fecundities (Table 4) of 76.8 eggs for macropterous females and 33.0 eggs for brachypterous females are considerably lower than 148.5 eggs in the third generation and 543.1 eggs in the natural conditions recorded in Japan by Kisimoto (1965), 805 to 809 eggs recorded also in Japan by Kuno (1968) and 244·2 eggs per female, cultured on IR 9 - 60, in the Philippines (Bae & Pathak, 1970). Two reasons may account for the extremely low values obtained in these experiments: first the values represent eggs laid only during the first 10 days after emergence and secondly these represent eggs actually laid — realized fecundity only.

Table 4 Mean fecundity of *N. lugens* female cultured on rice variety TN 1 during first 10 days after emergence

N. lugens Adult	*Number of individuals*	*Total number of eggs*	*Mean fecundity (Mean±SD)*	*t-value*
Macropterous	12	921	76.8±8.1	
Brachypterous	12	376	33.0±3.3	3·0*

* Significant at 2·5% level.

N. lugens from Sri Lanka, cultured on IR 9 - 60, was reported to have longevities of 15.8 days for macropterous males and 16.7 days for macropterous females and mean fecundities of 75.9 eggs for macropterous females and 45.8 eggs brachypterous females (Daniel, 1982). These values are similar to those obtained in these experiments on *N. lugens* cultured on TN 1. These similar values obtained from TN 1, a rice variety with no resistant gene, and IR 9 - 60, a variety moderately resistant to biotypes of *N. lugens* from Philippines, would seem to confirm that geographically separated populations of *N. lugens* are more likely to have taxonomic differences of biological significance (Claridge & Den Hollander, 1980; Daniel & Rajendram, 1982).

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OBSERVATIONS ON THE BIOLOGY OF *CYRTORHINUS LIVIDIPENNIS* (HEMIPTERA : MIRIDAE)

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ABSTRACT The biology of the predaceous mirid *Cyrtorhinus lividipennis* Reuter was studied. Eggs averaged 0.77 mm long and 0.20 mm wide; the adult male 2.88 mm long and 0.92 mm wide and the female 2·94 mm long and 1.04 mm wide. Mean incubation period of eggs was 7.36 days; total nymphal development 11.72 days; and longevity of adult male 16.47 days and adult female 12.33 days. Mean fecundity was 30.08 eggs per female. Longevity and fecundity of the Sri Lanka population are intermediate between Philippines and Thailand on the one hand and Hawaii and India on the other.

Introduction

Cyrtorhinus lividipennis Reuter is a predator of the planthopper and leafhopper pest complex of rice in Southeast Asia and the Pacific (Chiu, 1979; Yamatsu *et al.*, 1981; Liquido & Nishida, 1983). Its significance as a potential biological control agent of rice pests is due to its widespread distribution in rice growing countries. It has been recorded from India, Sri Lanka, Burma, Indonesia, Thailand, Malaysia, Philippines, Japan, China, Taiwan, New Guinea, Fiji, Mariana Islands, Caroline Islands, New Hebrides, Guam, Great Nicobar and Australia (Usinger, 1946; Swezey, 1946; Suenaga, 1963). In Sri Lanka, *C. lividipennis* has been reported from the districts of Amparai (Otake *et al.*, 1976; Rajendram, 1982; 1984), Batticaloa, Kilinochchi and Jaffna (Rajendram, 1982; 1984) and Kandy and Kurunagala (Rajendram : unpublished data).

Studies on the biology of *C. lividipennis* have been carried out in the Philippines (Reyes & Gabriel, 1975), Thailand (Tanangsnakool, 1975), India (Samal & Misra, 1977; Pophaly *et al.*, 1978) and Hawaii (Liquido & Nishida, 1985). The present paper describes the results of laboratory studies on the biology of *C. lividipennis* from Sri Lanka, including morphometrics, longevity and fecundity.

Materials and Methods

Mass cultures of *C. lividipennis* were maintained in the laboratory by releasing gravid females, collected from rice fields in Kilinochchi, into a plastic sleeve cage (30×25×25 cm) with potted plants of rice variety Bg 90-2, 4-5 weeks old,

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along with different stages of *Nilaparvata lugens* (Stål) which served as the host. Rice plants, on which *N. lugens* fed, were changed regularly. The temperature in the laboratory registered a range of 26 - 32°C and relative humidity 40 - 92%.

Studies on incubation, fecundity and longevity were carried out on *C. lividipennis*, transferred, by means of an aspirator, into a chimney cage. The chimney cage was made up of a potted plant, of rice variety Bg 90 - 2, 4 - 5 weeks old, with a chimney, 20 cm high, fitted over the rice plant. Various stages of *N. lugens* were introduced into the chimney cage, as required.

To determine the incubation period of eggs, a gravid female *C. lividipennis* was transferred into a chimney cage. After 24 h, the insect was removed and the plant observed daily for 15 days for emerging nymphs. The number of nymphs was noted and the incubation period determined. After 15 days, the plant was dissected, under a dissecting microscope, and the number of unhatched eggs determined.

In studies on fecundity, a male-female pair of newly emerged *C. lividipennis* adults was transferred into a chimney cage and observations made daily and the number of emerging nymphs counted. After 15 days, the plant was dissected and the number of unhatched eggs noted. At the death of the female, the abdomen was dissected and the number of unlaid eggs noted.

In studies on nymph size and duration newly emerged nymphs were transferred singly, by means of an aspirator, into individual test tubes (15 × 1.5 cm) containing a Bg 90 - 2 rice seedling kept in place by moist cotton. A gravid *N. lugens* female was also introduced to provide eggs as food for the nymph. The nymphs were transferred to test tubes with fresh plants every three days, observed daily for signs of moulting, the exuviae removed and the duration of instar noted on the day of moulting.

Adults were sexed upon emergence and their body length and width measured. Longevity of adults was determined by pairing newly emerged adults in the chimeny cage. They were then observed daily to obtain data on longevity.

When two values were compared, t-test was employed to determine significance.

Results and Discussion

The dimensions of eggs, nymphs and adults are presented in Table 1. The body length of adult females, 2.94 mm, was slightly larger than that of males, 2.88mm. The adult dimensions are in general agreement with values reported from other countries. The body lengths of male and female adults and first and fourth instar nymphs were respectively 2.28, 3.04, 0.71 and 2.09 mm in Philippines, 2.34, 2.43, 0.86 and 1.98 mm in India, and 3.08, 3.45, 0.85 and 2.18 mm in Hawaii (Reyes & Gabriel, 1975; Samal & Misra, 1977; Liquido & Nishida, 1985).

Table 1 Dimensions of *C. lividipennis* egg, nymph and adult.

Developmental Stage		*No. of individuals*	*Lenth (mm) (Mean±SD)*	*Width (mm) (Mean±SD)*
Egg		30	0.77±0.04	0.20±0.03
Nymph:	1st instar	30	0.87±0.02	0.23±0.05
	2nd instar	30	1.49±0.20	0.46±0.04
	3rd instar	30	1.76±0.21	0.64±0.10
	4th instar	30	2.49±0.30	1.07±0.22
Adult:	Male	30	2.88±0.16	0.92±0.12
	Female	30	2.94±0.37	1.04±0.22

The incubation period of eggs, developmental period of nymphal instars and longevity of adults are given in Table 2. The mean incubation period of 7.36 days of *C. lividipennis* in Sri Lanka is in general agreement with values of 7.56 days reported from the Philippines (Reyes & Gabriel, 1975) and 7.3 days from India (Samal & Misra, 1977). The total duration of nymphal instars also does not show much variation, being 11.72 days in Philippines, 12.1 days in India and and 12 66 days in Hawaii (Reyes & Gabriel, 1975; Samal & Misra, 1977; Liquido & Nishida, 1985).

Table 2. Developmental period of *C. lividipennis* egg and nymph and longevity of adult

Developmental Stage		*No. of individuals*	*Range (Days)*	*Duration (days) (Mean±SD)*
Egg		30	6 - 8	7.36±1.71
Nymph:	1st instar	30	2 - 3	2.47±0.51
	2nd instar	30	2 - 4	2.78±0.78
	3rd instar	30	2 - 4	3.00±0.65
	4th instar	30	3 - 4	3.47±0.57
Adult :	Male	30	3 - 37	16.47±2.60
	Female	30	2 - 25	12.33±2.69

The longevity of males, 16.47 days, is significantly higher than that of females, 12.33 days, (Table 2 : t=2.19; $P < 0.05\%$). Longevity values of Sri Lanka population of *C. lividipennis* are also in general agreement with the values reported from Philippines, 16.7 days for males and 14.8 days for females (Reyes & Gabriel, 1975), but considerably smaller than 19.2 and 21.7 days for male and female adults

reported from Hawaii (Liquido & Nishida, 1985). In India, Samal & Misra (1977) reported a combined longevity of 7.4 days for male and female adults while Pophaly *et al.* (1978) reported a combined longevity of 40 days.

Mean realized fecundity of 30.08 eggs per female in the present study is higher than 13.5 eggs reported from the Philippines (Reyes & Gabriel, 1975) but lower than 98.71 eggs reported from Hawaii (Liquido & Nishida, 1985).

Ecologically, change in body size has been related to competition for and allocation of available resources (Price, 1975). Liquido & Nishida (1985) reporting on variation in number of nymphal instars of *C. lividipennis* from different countries concluded that the inconstancy in the number of moults had not influenced the integrity of the quantitative genetic expression of body size. The present results confirm these conclusions. We can also confirm that there is no apparent adaptive reason for *C. lividipennis* to alter its body size.

Although Liquido & Nishida (1985) maintained that high fecundity and longevity in the Indian population of *C. lividipennis* as reported by Pophaly *et al.* (1978) combined r and k stretegist characteristics of long adult life and high fecundity, they concluded that there was no apparent relationship between longevity and fecundity. These findings are also confirmed by the present study.

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STUDIES ON *XANTHOMONAS CITRI* (HASSE) DOWSON, CAUSING CANKER DISEASE OF CITRUS

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ABSTRACT The present investigation was undertaken with a view to obtaining some basic information about some of the factors that are conducive to the infection of citrus plants by *Xanthomonas citri* (Hasse) Dowson. Temperature of about 30°C and 100% relative humidity seem to provide ideal conditions for the infection to occur. The disease can be severe during both dry and wet conditions. The bacteria gain entry predominantly through wounds and occasionally natural openings. Infection usually takes about seven days to develop from the time of inoculation, under laboratory conditions, and about eighteen days after inoculation in field. Chloramphenicol and tetracycline suppress the growth of the bacteria in vitro under laboratory conditions at a concentration of 100 ppm and Antracol, Streptomycin and Copper Sandoz are effective at a concentration of 1000 ppm. In vivo studies indicate that tetracycline inhibits symptom development at 100 ppm in detached leaves, while chloramphenicol and stremptomycin together with Copper Sandoz and Cupravit are effective in suppressing symptom development at 1000 ppm.

Introduction

The canker disease of citrus, *Citrus aurantifolia* (Christm) Swingle, was earlier thought to be caused by the bacterium, *Pseudomonas citri* which was subsequently renamed *Xanthomonas citri* (Hasse) Dowson and reported by Agrios (1978). This is one of the commonest diseases of citrus plant and is world wide in its occurence. The pathogen affects mainly the leaves, fruits and sometimes the stem.

The bacterial canker of citrus has been observed in all citrus growing areas in Jaffna and the disease may probably have been the cause of the decline in citrus yields in Sri Lanka in the recent past. The frequent occurrence of this disease on citrus plant prompted the present investigation on some aspects of the biology of the disease causing organism.

This disease has been observed in many plants of the citrus group, including orange, grapefruit, lime, mandarin and takity seedless variety. Observations have shown that orange appears to be the most resistant to bacterial canker, whereas takity seedless appears to be the most susceptible variety.

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Symptoms of the disease are easily noticeable in leaves where they appear as circular, brown, necrotic areas with scabby excrescences on the leaf surface. These areas are surrounded by a pale green or yellow halo. As the disease advances the affected area becomes corky.

Damages on the infected leaves reduce the photosynthetic area and as a consequence the productivity of the plant will be affected. Infection on the fruits creates an ugly appearance and such fruits undergo spoilage more quickly. It was therefore decided to study the pathogen and to explore possible chemical control measures against it.

Materials and Methods

Isolation of pathogen and host source

The pathogen *Xanthomonas citri* was isolated from leaves of naturally infected citrus plants. Infected portions of the leaf tissue were macerated with sterile distilled water, after surface sterilization with 0.01 M mercuric chloride solution. The suspension thus prepared was streaked on nutrient agar medium and the plates were incubated at room temperature for 2-3 days. The bacterial culture was purified and maintained as a mono-culture. For long term study the culture was kept in a refrigerator.

As a source of host material leaves obtained from healthy *Citrus aurantifolia* plants were used. Inoculation was carried out generally on the leaves between the second and seventh positions on the twig, as they showed fair susceptibility to the disease. Before inoculation the leaves were surface sterilized and subsequently washed thoroughly with distilled water.

Inoculation of leaves

During inoculation, pricks were made gently on the leaves to cause minute non lethal wounds by means of a sterile pointed needle. The leaves were then dipped in a sample of bacterial suspension which was prepared by suspending a loopful of the inoculum from a 24 h old culture in sterile distilled water. The concentration of the inoculum was usually determined prior to inoculation with a haemocytometer.

After inoculation the leaves were kept in transparent plastic boxes lined with moist blotting paper and incubated at room temperature. The extent of infection was assessed after eight days of incubation, as the mean number of infection sites obtained per leaf.

Studies on the course of development of disease

Initially the development of infection on leaves was studied under laboratory conditions. For this purpose, leaves that were inoculated with the

baterial suspension were kept in humid transparent plastic boxes and maintained at room temperature. The leaves were examined for changes associated with the disease daily for about twelve days.

Similar studies were made under natural conditions on plants that were grown in the botanical garden. For this purpose, actively growing healthy twigs were selected and the leaves inoculated with bacterial suspension and observed for symptoms upto a period of three weeks.

Transverse sections of the leaves through the infection sites were examined to discern the morphological and histological changes associated with the disease.

Effect of different methods of inoculation on the extent of infection

It was felt desirable to investigate the effect of different methods of inoculation of the pathogen to see which method was the most effective in causing infection. For this purpose, surface sterilized citrus leaves were divided into three sets. One set was inoculated by dipping the leaves that were not subjected to prior wounding, in the bacterial suspension. Another set was sprayed with bacterial suspension using an atomiser. This set too was not wounded. The third set was inoculated by treating with the bacterial suspension after pricking. All three sets were kept under identical conditions. Counts on the number of infection sites were made after eight days of inoculation.

Effect of physical factors on extent of infection

Effect of inoculum density. Bacterial suspensions of different concentrations were used to inoculate leaves of similar age by the pricking method and the mean value of infection sites per leaf was calculated.

Effect of temperature. In this, sets of leaves were inoculated with bacterial suspension by the pricking method and incubated at 25° C, 30° C and 35° C and the mean number of infection sites per leaf calculated.

Effect of moisture. Droplets of bacterial suspension were placed with a micropipette on leaves that were wounded. In one set of leaves the droplets were dried immediately after inoculation and the other set was kept wet throughout the period of incubation and the symptoms assessed as above.

Effect of chemicals on bacterial growth

The effect of Bordeaux mixture, Antracol, Copper Sandoz, Cupravit, streptomycin, tetracycline and chloramphenicol were investigated on the bacterium grown in nutrient agar medium (Wheeler, 1969; Mehrotra, 1980). For each chemical the compound prepared at concentrations of 100 ppm, 500 ppm and 1000 ppm was incorporated separately into molten nutrient agar. These plates were seeded with 0.10 ml of the bacterium at a concentration of 10^3 cells/ml. After two days of incubation at room temperature the number of colonies that developed in each plate was noted.

Effect of chemicals on development of infection in leaves

It was pertinent to find out if the chemicals used in the *in vitro* study in the previous experiment had a similar or variable effect on infection on the leaf. Leaves were surface sterilized and dipped in different concentrations of chemicals used in the previous experiment. After air drying the leaves were soaked in the bacterial suspension after making pricks and incubated at room temperature in petri dishes lined with moist filter paper. Controls were maintained.

Results

Course of disease development

Symptoms began to develop as brown spots on the fourth day after inoculation. Subsequently the area surrounding these spots became pale green in colour. By the sixth day, the surrounding area turned yellow and by this time light yellow corky out-growths appeared from the centre of the lesions. By about the eighth day after inoculation the center of the lesion turned brown and became hard. These resembled the typical canker symptoms observed in plants in the field.

In similar studies undertaken under natural conditions on plants that were grown in the botanical garden, the symptoms bagan to appear by about the fourth day after inoculation but typical symptoms appeared only after eighteen days.

Although the disease was observed on the upper and lower leaf surfaces the symptoms were more prominent on the upper surface. The affected areas showed the presence of corky protuberances. Both the palisade and spongy parenchymatous tissues were damaged. The infected cells became necrotic. The bacterial cells were found intracellularly within the mesophyll cells.

Methods of inoculation

The mean values of the number of infection sites per leaf as a result of pricking, spraying and dipping the leaves in the bacterial suspension were 7 ± 3, 2 ± 1 and 2 ± 1 respectively.

It appears that all three methods are effective in causing infection. However, pricking has been more successful in causing infection than the other two methods. This suggests that one of the prerequisites for successful infection is wounding which might happen under natural conditions when leaves can be damaged by wind, insects, or during handling of the crop. Infections that appeared on leaves that were not pricked suggest that the bacteria could also enter the leaf through natural openings such as stomata.

Effect of physical factors on the development of infection

Effect of inoculum density. The results given in the Table 1 show that bacterial concentrations of 10^6 cells/ml and above are required in order to cause successful infection.

Table 1. Effect of inoculum density on the production of infections.

Concentration of bacterial suspension in cells/ml	*Average number of infection sites per leaf (Mean(±SD)*
10^9	9±1
10^8	7±1
10^7	6±1
10^6	4±0
10^5	0
10^4	0

Effect of temperature. Observations on the number of infection sites revealed that at 30° C the infection was higher suggesting that this temperature favours infection.

Effect of moisture. It was observed that symptoms developed equally on the leaf surfaces that were kept moist after inoculation, as well as in those which were dried immediately after inoculation. This indicates that the bacteria can cause infection under both wet and dry conditions.

Effect of chemicals on bacterial growth. On nutrient agar medium the bacteria formed light yellow coloured colonies which were spherical with entire margin. The colonies were shiny with a convex surface. Individual bacterial cells were rod shaped without a capsule. They were gram negative and possessed only one flagellum. The cells measured 15 μm long and 7.5 μm wide.

The effects of the different chemicals on bacterial growth in nutrient agar medium are given in Table 2.

Table 2. Effect of chemicals on bacterial growth

Concentration of chemicals (ppm)	*Average number of colonies per plate on different chemicals (Mean ± SD)*						
	Bordeaux mixture	*Chloram-phenicol*	*Tetra-cycline*	*Copper Sandoz*	*Cupravit*	*Antracol*	*Strepto-mycin*
0(Control)	926±7	930±8	928±14	931±13	921±9	926±18	929±8
100	800±39	0	0	103±5	302±11	313±5	102±4
500	624±8	0	0	39±5	261±10	117±6	59±5
1000	354±11	0	0	21±4	221±8	0	16±2

The results indicate that chloramphenicol and tetracycline reduced the development of the bacteria dramatically by completely suppressing its growth at 100 ppm. Copper Sandoz, Antracol and streptomycin are effective in controlling the bacterial growth at a concentration of 1000 ppm, on artificial medium.

Effect of chemicals on the development of infection in leaves.

The results of this investigation are given in Table 3.

Table 3. Effect of chemicals on the development of infection in citrus leaves

Concentration of chemicals (ppm)	*Average number of infection sites per leaf on different chemicals (Mean ± SD)*						
	Bordeaux mixture	*Chloram-phenicol*	*Tetra-cycline*	*Copper Sandoz*	*Cupravit*	*Antracol*	*Strepto-mycin*
0 (Control)	7±1	8±1	9±2	7±1	7±1	7±1	9±1
100	4±1	2±1	0	3±0	6±1	6±2	2±0
500	4±0	1±1	0	1±1	3±0	4±1	1±1
1000	7±2	0	0	1±0	1±1	4±0	1±0

Tetracycline is highly successful since it completely inhibits the development of the symptoms in the leaves even at a concentration of 100 ppm, whereas chloramphenicol, streptomycin, Copper Sandoz and Cupravit are successful to a high degree at a concentration of 1000 ppm.

Discussion

Bacterial canker disease of citrus caused by *Xanthomonas citri* is one of the foliar and fruit diseases of citrus and has been found to cause infection in all groups of citrus plants. No systematic study of the disease has so far been carried out in Sri Lanka. Since there are no records of the damage caused to the citrus plant by the pathogen it has been difficult to estimate the quantitative losses or damages.

As a result of infection centres becoming necrotic and the development of corky protuberances on the leaf surface, the available photosynthetic area becomes less, which impedes the rate of photosynthesis in infected leaves. This will naturally affect the growth of the plant and the yield of fruits. Occurrence of disease on the fruit certainly impairs the quality of the fruit. However, further studies are necessary to assess these adverse effects.

The present investigations have also indicated that the pathogen gains access to leaves through natural openings such as stomata and through wounds caused artificially. However the latter seems to cause severe and successful infections. Also wounding of fruits caused by insect borers is the primary cause of bacterial entry into fruits

The requirement of the relatively low temperature and the presence of moisture on leaf surface may suggest that infections can be severe during rainy season. But the disease is also severe during dry conditions. This may be partly due to the low temperature prevailing in the night which is conducive to the entry of bacteria.

No control measures have so far been adopted against the bacterial canker of citrus. The present study indicates that particularly tetracycline along with the chemicals chloramphenicol, streptomycin, Copper Sandoz and probably Cupravit can be used at low concentrations for the control of the disease.

The present investigation only reveals certain conditions that favour disease incidence and provides some information on certain aspects of the biology of of the disease and the effect of some chemicals on the disease. Further studies are necessary to assess the extent of damage caused by the pathogen to citrus plants and to develop methods to suppress the disease under field conditions.

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STUDIES ON THE FRUIT ROT DISEASES OF BRINJAL, *SOLANUM MELONGENA* L.

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Vingnanam — Journal of Science 1 : 26—28 (1986)

ABSTRACT An investigation was carried out on the incidence and severity of the fruit rot diseases of brinjal, *Solanum melongena* L. Eleven species of fungi associated with brinjal have been isolated and identified. Pathogenicity studies have revealed that five of these fungal species are responsible for causing rot in brinjal. These are *Phoma* spp., *Botryodiplodia theobromae*, *Rhizopus* spp., *Absidia* spp., and *Fusarium* spp. The chief symptoms produced by these have been recorded.

Introduction

Brinjal, *Solanum melongena* L. is an economically important fruit and is used as a vegetable throughout the world. Fruit rot of brinjal is an important post harvest disease that causes considerable losses during transit and marketing of the fruit. It is widely prevalent in the Jaffna district in Sri Lanka, particularly during storage and transit of the produce.

Materials and Methods

General. The brinjal variety Thirunelvely purple was selected for this investigation. The survey was carried out during two harvesting seasons, the rainy season extending during the months of November and December and the dry harvesting season during the months of March and April, on local plantations, and subsequently at the markets in Thirunelvely and Atchuvely in Jaffna district. The incidence of the fruit rot was assessed as a percentage of the sum total of fruits at each location. A cross section of the farmers and vendors at the markets was also interviewed on the handling techniques and losses occuring during harvest, in transit, during storage and at the stalls.

Isolation of the pathogens. Rotten fruits were collected from plantations and markets for investigation in the laboratory. The pathogens were isolated by cutting discs (3 mm thick) of rotten tissue under aseptic conditions, after surface sterilization in 0.01% mercuric chloride. The discs were then plated on malt extract agar and incubated at 30°C. Pure isolates of the causative organisms were obtained by the standard technique.

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Determination of the pathogenicity of the fungi. Healthy fruits were surface sterilized and later washed in three changes of sterile distilled water. A short cylinder (4 mm long) was bored in the fruit with a cork borer (1.5 cm diameter), making sure that the bored tissue was intact within the fruit after the cork borer was withdrawn. Two drops of the spore suspension (density, 4.8×10^5/ml) of an isolate were placed around the outline of the wound caused by the boring. Comparable controls too were placed inside plastic boxes lined with moist filter paper and regular observations made. Reisolation of the organisms was carried out and Koch's postulates established.

Results and Discussion

Fungal species associated with the rot

Elven species of fungi were found to be associated with brinjal fruits in the present investigation. The fungal species encountered are listed below ;

1) *Phoma* spp.
2) *Botryodiplodia theobromae*
3) *Fusarium* spp.
4) *Rhizopus* spp.
5) *Absidia* spp.
6) *Nigrospora* spp.
7) *Bipolaris hawaiiensis*
8) *Curvularia clavata*
9) *Trichothecium roseum*
10) *Cylindrocarpon* spp.
11) *Cochliobolus australiensis*

Test for Pathgoenicity

In pathogenicity studies out of the elven fungal species encountered, only *Phoma, B. theobromae, Fusarium, Rhizopus and Absidia* were found to be pathogenic. Previous reports have mentioned only *Phomopsis vexans* as the causative agent of the fruit rot of brinjal (Pawar and Patel, 1957; Abeygunawardena, 1969; Chowdhry and *Hasija*, 1979).

Conditions favouring incidence of severity of the disease

Harvesting of fruits is done manually. In the course of the survey it became evident that as a result of some of the handling practices adopted during harvesting, packing and transportation, a sizeable percentage of the fruits acquired wounds which facilitated the development and spread of the rot disease. Insect boring of the fruits too was commonly observed both in the fields and in the markets which too made the fruits more susceptible to infection.

The incidence of fruit rot in the field was low, (1–4%). However, in plantations where harvesting was unduly delayed, higher levels of incidence (10-70%) were recorded. The incidence and severity of the rot appeared to increase from the fileds to the markets where as much as 30% and 40% of the produce was lost during the dry and rainy harvesting seasons respectively.

Chief symptoms exhibited by the different fungal species

Phoma spp. The disease first appeared as minute dull sunken and dusky purple spots which later merged forming large rotten areas with concentric rings of fungal growth. Within one week, the rotten areas became covered with black heads, which when mature produced conidia At a later stage the infected fruits were observed to be covered with grey mycelial mats from which numerous pycnidia developed. There has been a report that the species *Phoma* is the same as *Phomopsis vexans* which is known to cause fruit rot in brinjal; (Chowdhury and Hasija, 1979).

B. theobromae. The appearance of symptoms occured only 5-8 days after inoculation. Initially water soaked lesions appeared, but as the disease progressed, the infected regions appeared dark brown and depressed, being surrounded by a water soaked halo. At later stages (15 days after inoculation), the lesions became covered with greyish mycelium of the causative organism and numerous pycnidia developed on tnem.

Rhizopus spp. The symptoms started appearing 24 hours after inoculation as circular pale brown water soaked areas which enlarged rapidly covering a grater part of the fruit. The flesh became soft and succulent. At later stages approximately four days after inoculation, whitish grey mycelium covered the surface of the collapsing fruit.

Absidia spp. The symptoms produced were very similar to those caused by *Rhizopus* spp.

Fusarium spp. The symptoms appeared 2 —3 days after inoculation as water soaked lesions, which were not as well defined as in the rot caused by *Rohizopus* spp. The lesions enlnrged, rapidly, turned brown and were covered by a white mass of mycelium which appeared powdery.

High humidity was found to enhance the growth of these fungi. The rots caused by *Phoma* spp. and *B. theobromae* were by far, the severest.

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THE POTABILITY OF JAFFNA GROUND WATER

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ABSTRACT Chloride and Hardness concentrations in ground water of "Jaffna area" were analysed with the aid of Time series analysis and Stochastic processes in statistics. The area selected for this research consists of the western portion of Jaffna peninsula, Sri Lanka which was marked as "Jaffna area" by the Water Resources Board (WRB) of Northern Region of Sri Lanka. In this area sixty eight samples, for which successive monthly data are available from the regional office of the WRB from January 1979 to June 1984 were selected for analysis. The findings show that while the chloride concentration increased with time significantly, Hardness tends to remain unchanged.

Introduction

Ground water is a major natural resource of Jaffna peninsula, Sri Lanka, and it has been used for domestic, agricultural and industrial purposes. The demand for ground water has increased considerably over the past two decades. Rainfall is the only source of recharge for the ground water. Seasonal rainfall, its high variability and over-extraction are the factors which cause the salinity problem in ground water to an alarming degree (Puvaneswaran, 1986). The aim of this work is to analyse the chemical properties such as Chloride and Hardness concentration of the ground water over a period of 66 months from January 1979 to June 1984. An attempt is also made to predict the future potability of ground water resources in a particular area in Jaffna town.

Materials and Methods

The area selected for this research is the western portion of Jaffna peninsula, which is a triangular area having vertices at Jaffna town, Moolai and Thondaimannar (Fig. 1).

Monthly data were available for chloride and Hardness for a period of 66 months from January 1979 to June 1984 at the Water Resources Board (WRD), Jaffna. No data are available after this period. The WRB has collected water samples from 250 wells on a random basis in the "Jaffna area". However only 150 samples gave successive data for the period specified above. These wells were plotted on a map to show spatial distribution of the wells and purposive sampling method was then applied to a select sixty eight wells among them Figures 1 and 2. When selecting the wells, due attention was paid to obtain a minimum of one sample and a maximum of four samples from a given place to represent the study area. The decision as to how many samples should be selected from a place depended on the total number of wells in that area. The sample sizes selected in each place depended solely on the density of the population. Since purposive sampling method was used, a certain amount of subjective decision was also involved in selecting the samples.

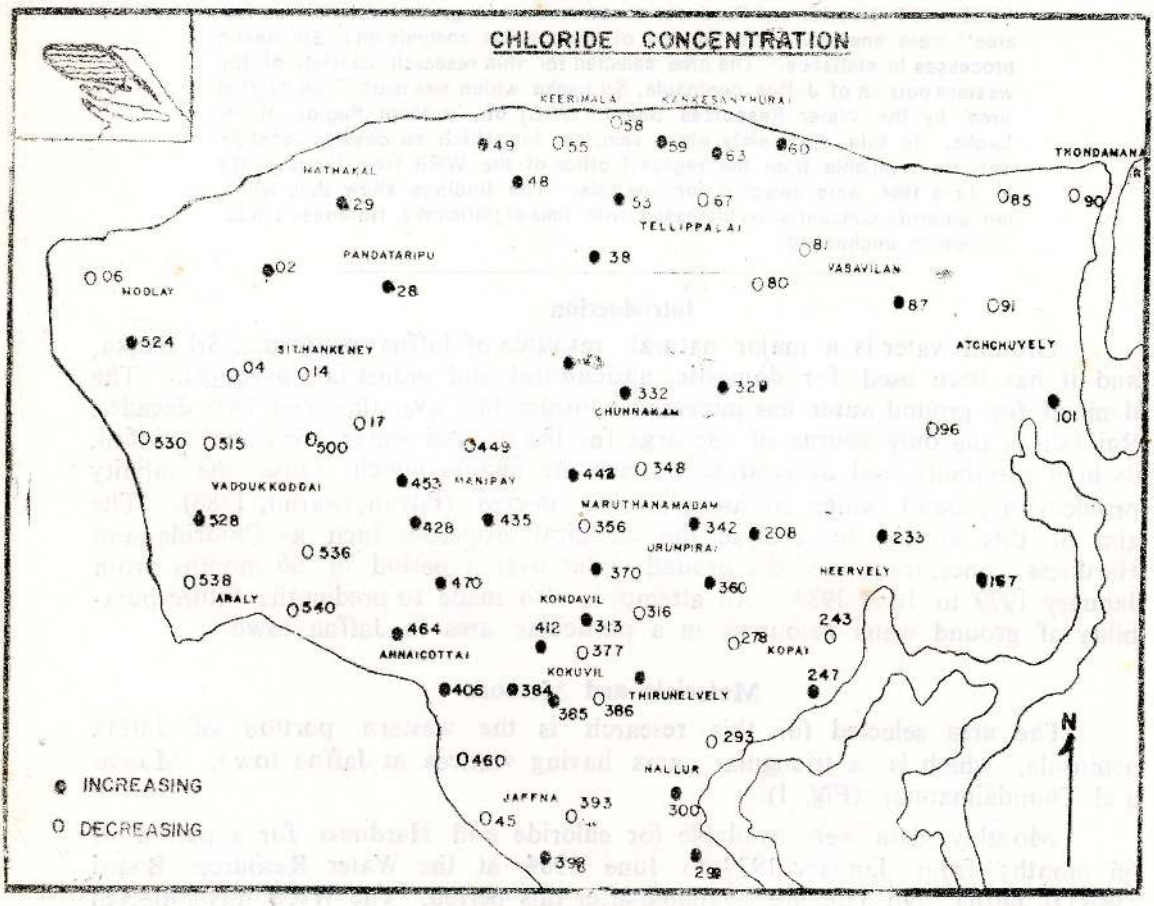

Fig. 1. Distribution of the sampled wells, separated on the basis of increasing (●) and decreasing (O) chloride concentration trends in the study area in the Jaffna peninsula.

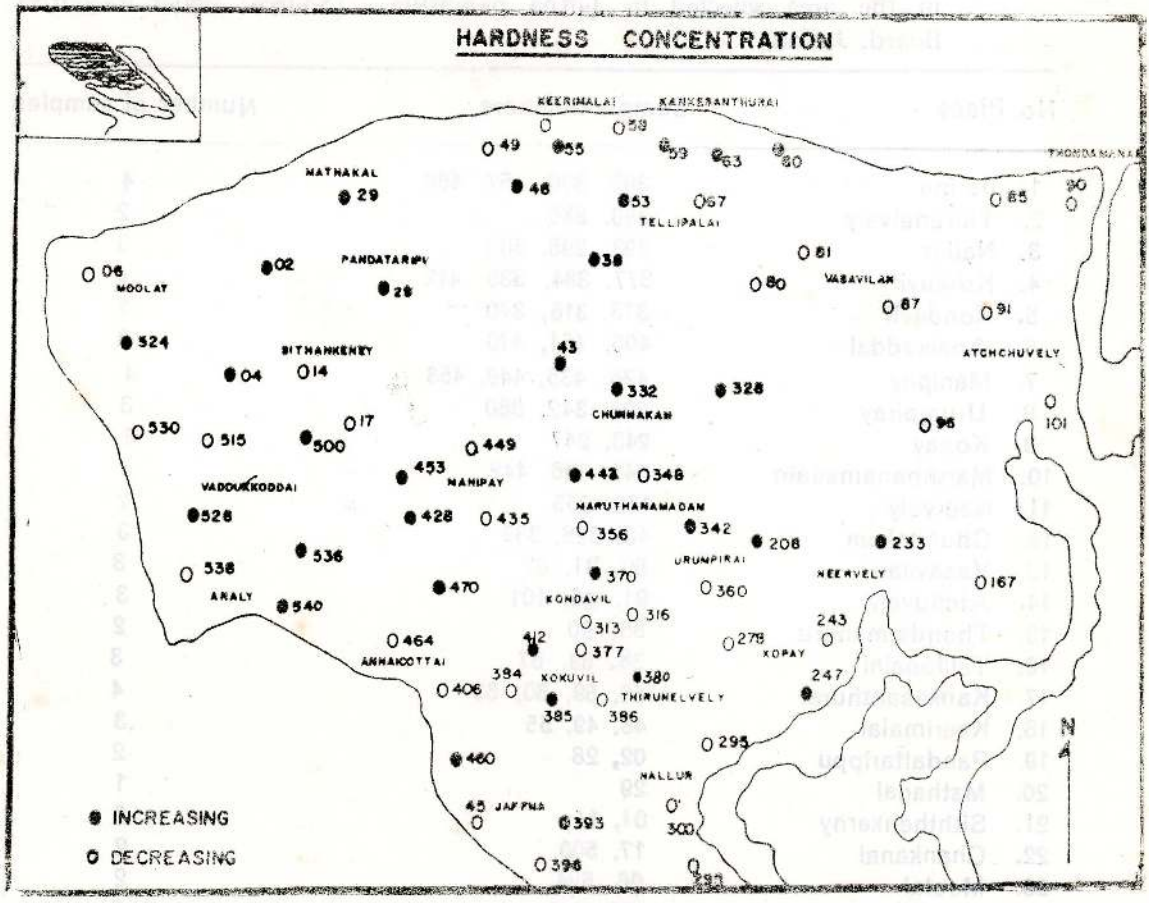

Fig. 2. Distribution of the sampled wells, separated on the basis of increasing (●) and decreasing (O) hardness concentration trends in the study area in the Jaffna peninsula.

Although data were available for only a short period of 66 months an attempt has been made to use these data to elucidate some facts about the ground water in Jaffna. The locations and samples selected for this study and the actual numbers of samples at each location are given in Table 1.

Table 1: The distribution of the samples used for analysis, in the different locations, in the area selected in Jaffna peninsula. (Source: Water Resources Board, Jaffna).

No.	Place	Sample numbers	Number of samples
1.	Jaffna	393, 396, 457, 460	4
2.	Thirunelvely	380, 386	2
3.	Nallur	293, 298, 300	3
4.	Kokkuvil	377, 384, 385, 412	4
5.	Kondavil	313, 316, 370	3
6.	Anaikoddai	406, 464, 470	3
7.	Manipay	428, 435, 449, 453	4
8.	Urumpiray	208, 342, 360	3
9.	Kopay	243, 247	2
10.	Maruthanamadam	348, 356, 442	3
11.	Neervely	159, 233	2
12.	Chunnakam	43, 328, 332	3
13.	Vasavilan	80, 81, 87	3
14.	Atchuvely	91, 96, 101	3
15.	Thondaimanaru	85, 90	2
16.	Tellippalai	38, 53, 67	3
17.	Kankesanthurai	58, 59, 60, 63	4
18.	Keerimalai	48, 49, 55	3
19.	Pandattarippu	02, 28	2
20.	Mathagal	29	1
21.	Siththenkerny	04, 14	2
22.	Chankanai	17, 500	2
23.	Moolai	06, 524	2
24.	Araly	536, 540	2
25.	Vaddukoddai	515, 528, 530	3

The chloride level which is related to the salinity of water is the Chloride (Cl) concentration in water. The Hardness level is the total concentration of Calcium (Ca), Magnesium (Mg) and Sulphate (SO_4) in water. Since the percentage composition of other substances such as Manganese (Mn), Iron (Fe), Copper (Cu), Phenolic compounds and Carbon-Chloroform extract were very low in the Jaffna ground water, these were not analysed. For Stochastic processes, raw data were classified according to the drinking water standard specified by the World Health Organization (WHO) listed in Table 2.

Table 2: Drinking water standand for different substances found in water specified by World Health Organization. (Source: Water Resources Board, Jaffna.)

Substances	Maximum acceptable level	Maximum allowable level
Manganese	0.100	0.500
Iron	0.300	1.000
Copper	1.000	1.500
Calcium	75.000	200.000
Magnesium	50.000	150.000
Chlorine	200.000	600.000
Sulphate	200.000	400.000
Phenolic	0.001	0.002
Carbon, Chloroform extract	0.200	0.500

Results

Trend Analysis

The observed monthly data (January 1979-June 1984) consist of 66 monthly time series values of Chloride and Hardness. These data can be analysed with the aid of time series analysis described in Appendix 1. Five -month moving averages have been calculated for Chloride and Hardness to find the linear trend. The original observations, second step moving average trends and linear trends of increasing and decreasing Chloride concentration are illustrated in Fig. 3 and 4 for two samples namely well No. 393 and well No. 396. The linear trend values derived reveal that Chloride concentration decreases to 3.37 ppm / month in sample well 393 and increases to 7.26 ppm / month in sample well 396.

From the trend analysis 136 trend equations were found for Chloride and Hardness. By considering the tangent of each line one could find whether the line decreases or increases. If a trend line decreases, the time series generally decreaes and vice-versa. The findings are given in Fig. 1 and 2.

Seasonal Analysis

Among one hundred and thirty six time series of Chloride and Hardness, only one time series was seleted for detailed study of seasonal analysis and the seasonal indices have been found. The Chloride concentration in sample 460 in Jaffna town was selected for a detailed study. In this analysis one year was considered a short run and the twelve months considered were twelve seasons. Seasonal fluctuations (Indices) were obtained by using the original time series.

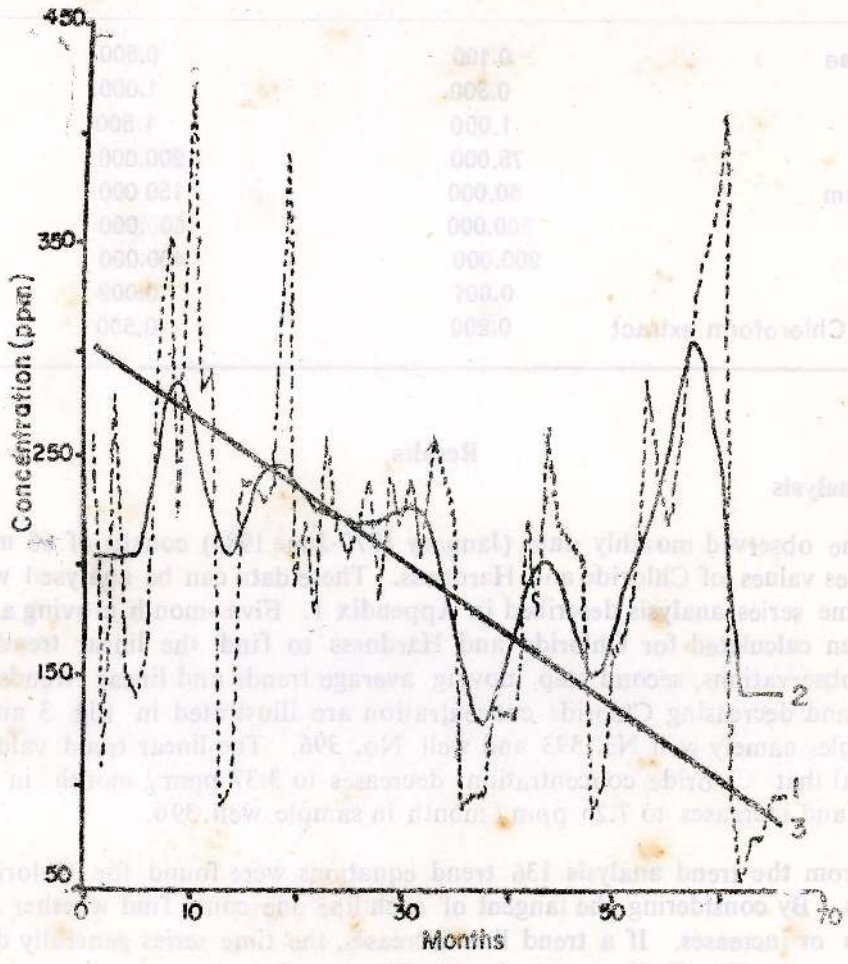

Fig. 3. Chloride concentration (ppm) in the water sampled from well No. 393 over a period of 66 months, showing the decreasing trend. Curve (1) shows actual values, curve (2) the moving average and curve (3) the linear trend.

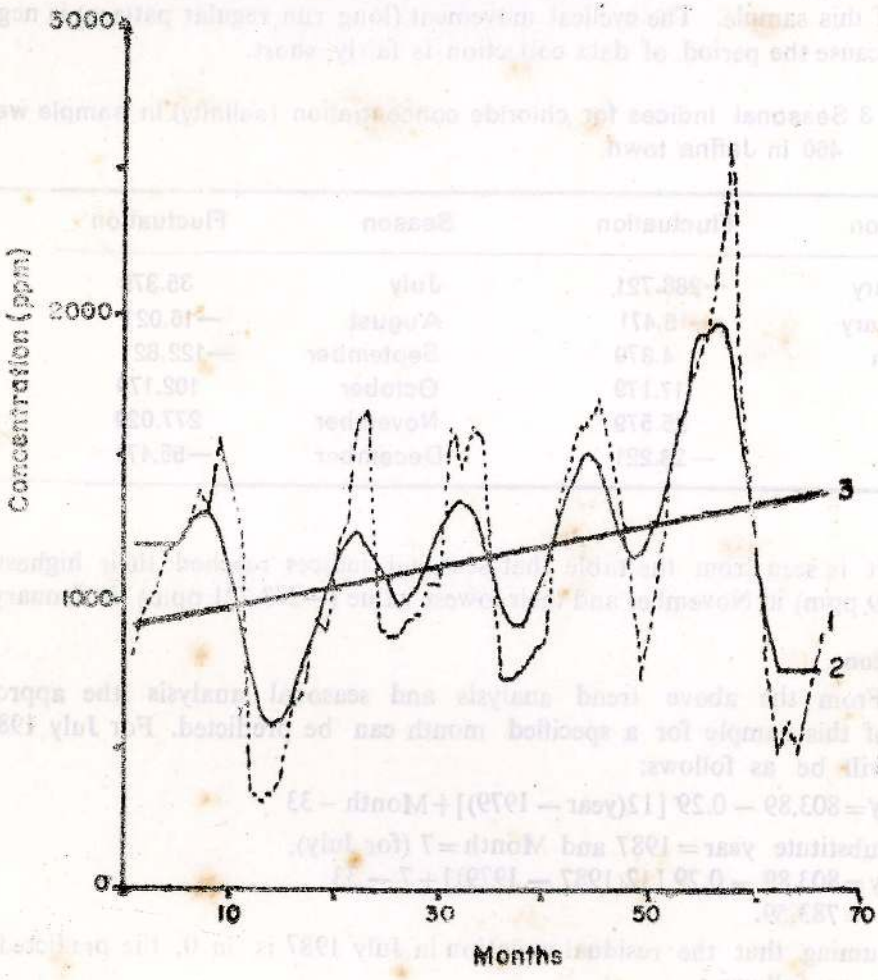

Fig. 4. Chloride concentration (ppm) in the water sampled from well No. 39_9 over a period of 66 months, showing the increasing trend. Curve (1) shows actual values, curve (2) shows the moving average and (3) the linear trend.

The additive model: $O=T+S+R$ is used, where O, T, S and R are original observation, trend value, seasonal variation (regular pattern) and residual variation (irregular pattern) respectively. In this model, trend values are calculated by finding the first step five month moving averages. The sixty observations from January 1979 to December 1983 were used for this analysis. Table 3 gives the seasonal indices of this sample. The cyclical movement (long run regular pattern) is neglected here because the period of data collection is fairly short.

Table 3 Seasonal indices for chloride concentration (salinity) in sample well No. 460 in Jaffna town.

Season	Fluctuation	Season	Fluctuation
January	—288.721	July	35.379
February	—15.471	August	—16.021
March	4.379	September	—122.821
April	17.179	October	102.179
May	25.579	November	277.029
June	—23.221	December	—55.471

It is seen from the table that seasonal indices reached their highest value (277.029 ppm) in November and their lowest value (—288.721 ppm) in January.

Prediction

From the above trend analysis and seasonal analysis the appropriate value of this sample for a specified month can be predicted. For July 1987 the value will be as follows:

$$y=803.89-0.29\,[12(\text{year}-1979)]+\text{Month}-33$$

If we substitute year = 1987 and Month = 7 (for July),

$$y=803.89-0.29\,[12(1987-1979)]+7-33$$
$$=783.59.$$

By assuming that the residual variation in July 1987 is in 0, the predicted value will be as follows :

$$O=T+S+R$$
$$=783.59+35.379+0$$
$$=818.969 \text{ ppm}$$

Stochastic Analysis

Stochastic analysis was used to analyse sample No. 460. The technique used in this study was successfully used in hydrological problems (Todorovic, 1978). The two state Markov-Chain described in Appendix II was used for the analysis. The states of the concentration GOOD or BAD are denoted by G or B.

If an observation lies between the maximum acceptable and maximum allawable concentrations, it is classified as "GOOD" state and otherwise it is classified as "BAD" state. For Chloride these limits are 200 ppm and 600 ppm and for Hardness 300 ppm 750 ppm.

The state space is S=(G,B). The classification of states and transitions of states are given in the following Markov process

G G G G B B B B B B G G G G G G B B B B B B B B G B B B B B B B B B G B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B G G G G

The first step transition probability matrix is found and is;

$$P = \begin{array}{c} \\ G \\ B \end{array} \begin{array}{c} \begin{array}{cc} G & B \end{array} \\ \begin{pmatrix} 0.71 & 0.29 \\ 0.08 & 0.92 \end{pmatrix} \end{array}$$

The limiting probability matrix is calculated as

$$\text{Lt } P = \begin{array}{c} \\ G \\ B \end{array} \begin{array}{c} \begin{array}{cc} G & B \end{array} \\ \begin{pmatrix} 0.2162 & 0.7838 \\ 0.2162 & 0.7838 \end{pmatrix} \end{array}$$

Discussion

Among sixty eight samples selected for this study, twenty seven are decreasing and forty one are increasing in Chloride (Fig. 1). On the whole, increasing chloride samples elucidate the alarming situation of Chloride problems on the basis of statistical analysis. Therefore due attention has to be paid to manage the ground water resource before it reaches a stage where no planning could solve this problem effectively. Fig. 2, reveals that unlike Chloride concentration there is a balance between increasing and decreasing trends in the Hardness concentration in the samples studied. Among the sample wells, while thirty four show the increasing trend, the rest are decreasing. From the Stochastic analysis it is found, in the long run the probability limit of GOOD state to BAD state of ground water for a particular area in Jaffna town (Sample No. 460-Fig. 3), is as given in the following form.

Pr (GOOD) = 0.2162
Pr (BAD) = 0.7838

By comparing the above limiting probabilities it was elucidated that the chance for a "BAD" state is more probable than the chance for a "GOOD" state in the ground water of a particular area in Jaffna town.

The changing Chloride concentration has become a major problem in the ground water of Jaffna peninsula. Most of the fresh water wells face salinity problems seasonally or yearly. This may be due to intensive farming

practices using chemical fertilizers and pesticides which leach through soils and mix with the ground water. Further, over-extraction of water by machine pumping could also aggravate the salinity intrusion into the fresh water lens. The wells which are not subjected to the above problem may have better recharge conditions.

On the basis of the above analysis in the particular area, we conclude that the ground water of this area will become unsatisfactory. Percentage chloride in the water of the wells in this area may continue to increase leading to drinking water problems. Some drinking water wells may have to be eventually abandoned. Similar analysis for other stations will give meaningful results of the nature and type of water and its future potability. The need for more in-depth study of this problem in the future is indicated by the results.

Acknowledgements

I wish to acknowledge my gratitude to Mr. S. Kanaganathan, Computer Unit, Department of Mathematics and Statistics, and Mr. K. M. Puwaneswaran, Department of Geography, University of Jaffna, for their valuable suggestions during this study. I also wish to express my thanks to the Engineer and the Research Officer of the Water Resources Board for their help in collecting the data.

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Appendix I

Trend Line

The trend is the long term movement of a time series. We are interested in finding a trend in terms of an equation and expressing it graphically. With given data, a graph is plotted, and the problem becomes one of fitting a straight line to the data so as to show the long-run gradual growth of the time series.

In this paper since the observed values of each time series is given from January 1979 to June 1984, the linear trend values for five month moving averages are in the months of September and October 1981. When the linear trend line on the scatter diagram of a particular sample is plotted, January 1979 could be taken as origin when September and October 1981 will secure the 33rd and 34th positions respectively on the time axis.

Since we have the trend values for these months on time axis (X axis), we could measure the values of these two points on observation axis (Y axis). Hence, we have two points on X—Y plane. This can be used for plotting the linear trend line of the time series given for the sample. If we let the respective trend values be y_1 and y_2, then the two points are $(33, y_1)$ and $(34, y_2)$ for the linear trend line. The equation of the trend line can be written as follows:

$y = y_1 + (y_2 - y_1)(X - 33)$; If we modify the time variable X as;

$X = 12\ (\text{Year} - 1979) + \text{Month}$

the modified equation will be as follows;

$y = y_1 + (y_2 - y_1)\ (12 \text{ year} - 1979) + \text{Month} - 33$

By using the above equation sixty eight trend lines for the Chloride and Hardness concentration of each sample have been obtained and these could be used for forcasting for any month of the year after having derived appropriate seasonal index for a particular month.

Appendix II

Transition probability matrix

For a homogeneous markov-chain the nth step transition probability function for the n transitions from the state i to the state j is given by

$$P_{ij}(n) = Pr[X_n = j / X_o = i]$$

If the number of states in this markov chain is finite we may express these probabilities by a transition probability matrix.

In this paper, since two states were considered a 2 x 2 transition probability matrix was constructed. If the first step transition probability matrix of this two state Markov-chain is

$$P = \begin{pmatrix} 1-a & a \\ b & 1-b \end{pmatrix}; \quad o < a,\ b < 1$$

then the nth step transition probability matrix can be written as:

$$P^n = \begin{pmatrix} \frac{b}{(a+b)} + \frac{a(1-a-b)^n}{(a+b)} & \frac{a}{(a+b)} - \frac{a(1-a-b)^n}{(a+b)} \\ \frac{b}{(a+b)} - \frac{b(1-a-b)^n}{(a+b)} & \frac{a}{(a+o)} + \frac{b(1-a-b)^n}{(a+b)} \end{pmatrix}$$

where $O <= a, b <= 1$ and $-1 < 1 - a - b < 1$

For the limiting probability distribudion of states,

$$\lim_{n \to \infty} (P^n) = \frac{1}{a\ 1+b} \begin{pmatrix} b & a \\ b & a \end{pmatrix}$$

SHORT COMMUNICATION

A NEW METHOD FOR CULTURING SEEDLINGS OF PALMYRAH PALM *BORASSUS FLABELLIFER* L.

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(Department of Botany, University of Jaffna, Jaffna, Sri Lanka.)

Vingnanam – Journal of Science 1 : 40—43 (1986)

ABSTRACT The remotive mode of germination of palmyrah, *Borassus flabellifer* L. seed does not permit germination in handy transportable containers. Seed-free tubers initiated roots when planted in a medium maintained at 35° C, providing a basal temperature 10° C above ambient. The rooted tubers could be grown in handy polythene bags subsequently.

Introduction

The palmyrah palm, *Borassus flabellifer* L. has now been recognised as an underutilised palm of Asia and Africa. Endowed with characteristic pest and disease resistance and requiring very limited agricultural inputs, its potential as a plantation crop for the developing countries of the tropics remains largely untapped—Kandiah[1]. The FAO / DANIDA sponsored workshop on the palmyrah palm held in Jaffna, Sri Lanka in February 1983, highlighted the need for scientific investigation into many aspects of growth and cultivation of the palm. Kovoor (1983) subsequently reviewed the current state of knowledge of the palmyrah palm.

Most of the palmyrah palm stands of the world today are unplanned naturally established seedlings of the palm. Dearth of land and increase in population in the regions of palmyrah has already checked such natural establishment of palmyrah. Purposeful planting and protection of palm seedling has now become a necessity.

Seedlings raised in nurseries fail to re-establish in the field after transplanting. Raising seedlings in transportable nursery bags or pots has proved difficult due to the mode of germination of palmyrah seeds being 'remotive', where, on germination the cotyledonary sheath (apocolon) elongate into the soil to considerable depth carrying the embryo with it (Dassanayake and Sivakadachcham, 1973). The authors found that the apocolon grows out through the container and establishes in the soil below the container defeating the purpose of planting the seed in containers – Fig. 1 (a).

1. Kandiah, S. (1983) Some aspects of botany and ecology of the palmyrah palm, Borassus flabellifer L. FAO / DANIDA Palmyrah Workshop, Jaffna, Sri Lanka.

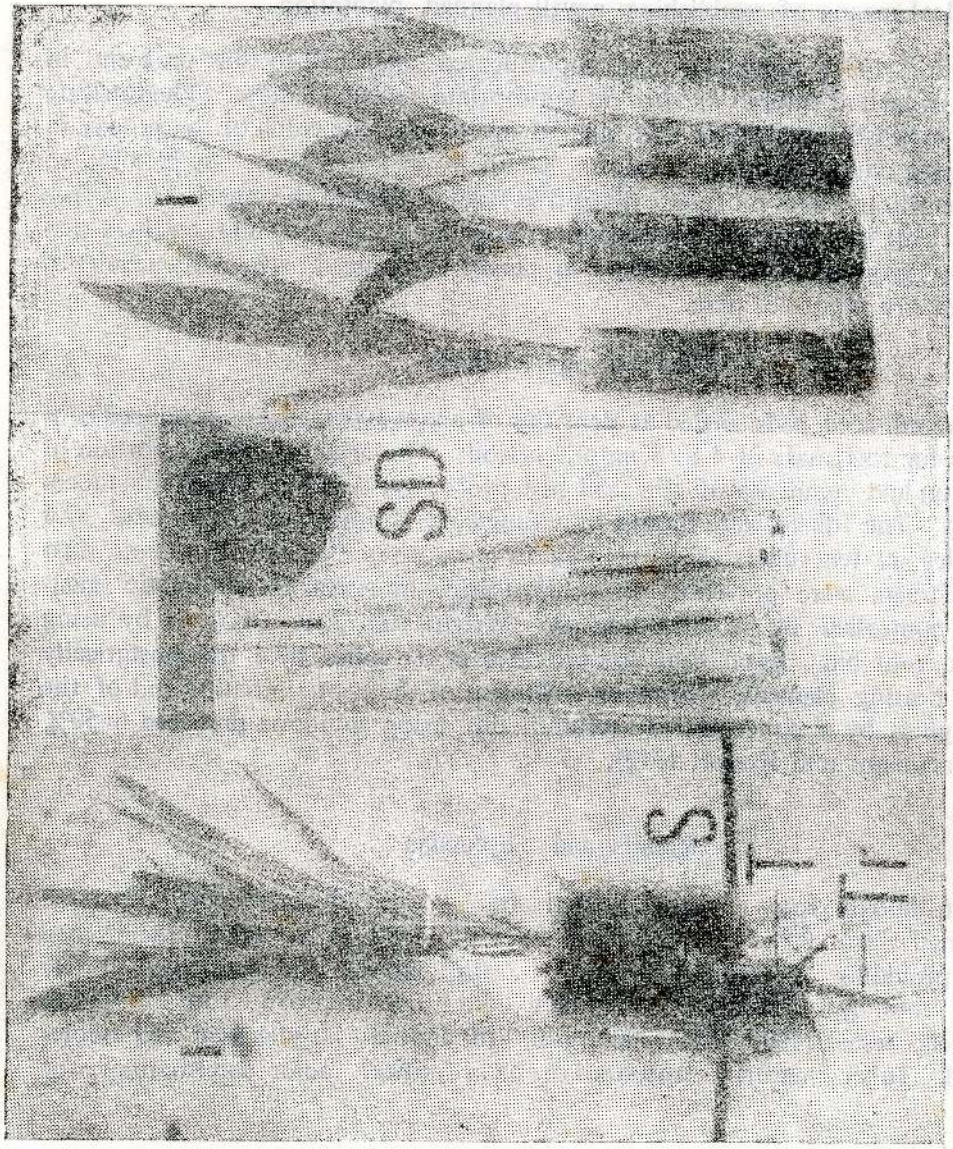

Fig.1 Palmyrah seedling (a) Seed germinated in 7"×9" polythene bag. S=soil level, T=Tuber, with cotyledonary sheath, Tr=Broken tap root. (b) Tubers used for root initiation, SD=seed before germination. (c) 16-month old root initiated tubers grown in 4"×9" polythene bags. Note, unlike in (a) roots are confined to the bag. Bar=4cm.

Palmyrah seeds planted in situ in the field establish poorly and percentage success was found to be as low as 10-20%, (Palmyrah Board, Sri Lanka - personal communication) even though Paulas and Muthukrishnan[2] reported more than 90% germination in two months in nursery beds. Hence planting seed in situ in the field is not an ideal means of establishing a well planned plantation.

Kovoor (1981) suggests a more sophisticated approach to this problem, in the culture of excised embryo *in vitro* on appropriate aseptic medium. The intricate nature and expenses involved in this method are beyond the reach of the grower in the developing countries of the tropics. Kandiah[3] reported that it is possible to induce adventitious roots on tubers (Seed-free seedling before the emergence of first leaf - Fig. 1 (b)) in a manner analogous to root induction on shoot cuttings and subsequently grow these rooted tubers in handy containers. The early results of these studies are reported here.

Materials and Methods

Palmyrah seed beds seeded at densities of about 300 seeds/m^2 produced tubers suitable for this study in 4 to 5 month period. The seed, sheathing portion of the cotyledon and remnants of the seed bed roots were removed from the tubers – Fig. 1 (b). The tubers were dipped in a fungicidal solution for few minutes, and then bundles of ten tubers were planted to a depth of 3 inches in a coir dust medium. Tubers were prevented from dessication by either an automatic misting system controlled by an electronic leaf (Wright Rain Ltd. UK.) or by using an enclosed root bin. Basal heat was provided in the latter by a thermostatically controlled heating element. Hormone treatment of the root initiating end of the tuber was given by a 'concentrated - solution- dip' using solutions prepared in 50% ethanol (Hartmann and Kester, 1972).

Results and Discussion

Even though root initiation started after a week, the percentage of rooted tubers varied from 30 to 80%. Bottom heat provided in root bin maintained at 35°C, providing a basal temperature 10°C above ambient, gave higher percentage rooting. Hormone treatment did not improve root initiation at the levels tested (1000, 2000, 3000 ppm) for indole - butyric acid and indole-acetic acid. Tuber maturity appears to be a critical factor determining root initiation.

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Fig. 1 (c) shows 16 month old seedling raised from root initiated tubers in polythene bags. These plants were found very suitable for managment under advanced nursery practices. They were also found very suitable for transport and remained viable up to 8 weeks when packed in bulk in polythene bags.

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SHORT COMMUNICATION

ALCOHOL FROM PALMYRAH PALM (*BORASSUS FLABELLIFER L.*) FRUIT PULP

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ABSTRACT The palmyrah fruit pulp which is a thick viscous liquid cannot be directly used for alcohol production but could be mixed with palmyrah sap (sweet toddy), another sweet sugar solution obtained from the same plant, and fermented. By fermenting diluted sap and fruit pulp, it is possible to economically convert most of the sugars to alcohol. 5.15% V/V alcohol was obtained from a fermenting medium of 6 parts of sweet toddy 4 parts of water and 2 parts of fruit pulp. Mixing of 'pinnatu', a fruit pulp product, with sweet toddy instead of fresh pulp also gave good recovery of alcohol.

Introduction

The fruiting season for palmyrah is between September to December. During this period large quantities of fruits are produced annually. Only a small proportion of these fruits are used to extract the pulp which is used for the preparation of 'pinnatu' — an edible product. Very recently Palmyrah Development Board of Sri Lanka has started producing soft drinks, cordials and various jams from the sweet pulp. The undiluted pulp constitutes 41% of the total fruit and contains 16 — 17% sugar both in the form of sucrose and invert sugar (Ratnasingam, 1967). The dried pulp referred to as 'pinnatu' contains 13.3% sucrose, 29.6% invert sugar and 75.6% total solids (Jeganathan, 1983[1]).

This paper reports some preliminary experiments on the use of fresh fruit pulp 'pinnatu' for the production of alcohol.

Experiments and Results :

Alcoholic fermentation on 'pinnatu' medium:

One litre of 'pinnatu' medium was prepared by dissolving 100g of 'pinnatu' in hot distilled water. The 10% 'pinnatu' medium was then sterilized by autoclaving at 15 lbs/sq. in. pressure for 15 minutes. The cooled medium was then inoculated with *Saccharomyces cerevisiae* (strain Py 1), a high alcohol

1 Jeganathan, N. (1983) Palmyrah fruit. Workshop on palmyrah - Organized by the Food and Agriculture Organization and The Palmyrah Development Board of Sri Lanka. 21—25th February, 1983.

fermentative yeast previously isolated from Palmyrah wine (Theivendirarajah and Chrystopher, 1984; Chrystopher, 1985). The initial yeast density was 2×10^6 cells/ml. The initial pH was found to be 5. The medium was allowed to ferment for 72 hours at room temperature of 28±2 °C.

The pH dropped to 3.6 after 24 h and remained steady. The alcohol content was determined after 48 and 72 hours of fermentation by ebulliometer method. Since the medium contained undissolved particles, the medium was filtered and the filtrate was analysed to determine the alcohol content.

The % of alcohol (v/v) at the end of 48 h and 72 h of fermentation was 1.7% and 2.1% respectively.

Increasing the amount of 'pinnatu' in the medium made the solution too thick, probably due to the presence of fibres, pectin and other insoluble carbohydrates. Thus it would not be feasible to use higher concentrations of 'pinnatu' in the medium for yeast fermentation as it could cause problems in subsequent racking and distillation processes.

Alcoholic fermentation on 'pinnatu' and 'sweet toddy' medium:

10 % 'pinnatu' medium contains only about 4.5 — 5% of sugar (w/v). This sugar content is too low to be used for alcoholic fermentation. In order to increase this amount to around 12 — 15% (w/v), the level which is used in most alcoholic fermentation processes, palmyrah sweet toddy was incorporated into the medium.

One litre medium of 'pinnatu' and sweet toddy (containing 5.5% sugar from 'pinnatu' and 6.5% sugar from palmyrah sweet toddy) was prepared and inoculated with the *Saccharomyces cerevisiae* (strain PY 1). The amount of alcohol produced after 48 h and 72 h of fermentation at room temperature was found to be 7.1% and 8.7% (v/v) respectively.

Alcoholic fermentation on palmyrah fresh fruit pulp and sweet toddy medium:

The undiluted fruit pulp which contains 16 — 17% (w/v) sugar, is a very thick, viscous liquid that cannot be used directly as a medium for fermentation. It was diluted with palmyrah sweet toddy and water to obtain a medium with a sugar content of about 10% (w/v). The medium contained 6 parts of sweet toddy (14% w/v sugar), 4 parts water and 2 parts fruit pulp (16—17% w/v sugar). This medium was inoculated with the same yeast strain, PY 1, and alcohol contents of 5.1% (v/v) and 5.2% (v/v) were observed at the end of 48h and 72h of fermentation respectively.

Discussion

The results of this preliminary study show that fresh fruit pulp and 'pinnatu' cannot be used as the sole source of raw material for alcoholic fermentation.

The sugar content will become low and not economical to ferment when a reasonable light, clear medium is prepared from fresh pulp or 'pinnatu' alone. The amount of alcohol (2.1% v/v) produced from a 10% w/v 'pinnatu' medium seems to be a reasonably good yield. The efficiency of conversion of sugar to alcohol is about 64%.

The results have shown that fresh fruit pulp or 'pinnatu' could be easily mixed with sweet toddy and used as a medium in this fermentation process. The recovery of 8.7% v/v alcohol from a 'pinnatu' — sweet toddy medium and 5.2% v/v alcohol from a fruit pulp — sweet toddy medium were good. The mixtures had 12% w/v and 10% w/v of total sugar contents respectively. By diluting with sweet toddy you could utilize more of the pulp and 'pinnatu' and thus be able to convert the sugar present in the pulp to alcohol.

The fermented solution is yellow in colour as opposed to the usual milky white appearence of 'toddy' and contains a lot of materials in suspension. It also imparts a strong aroma characteristic of the fruit pulp juice. (Hence this product cannot be consumed directly like the normal toddy). However, the alcohol can be distilled for the preparation of arrack or for other industrial uses.

There may be problems with regard to the use of fresh pulp and sweet toddy in a commercial production venture because these two raw materials are not available in sufficient quantities at the same time. The main palmyrah sweet toddy season is few months before the fruiting season. This can be overcome if more sweet toddy could be made available by the kaivetty method (i.e. from matured female inflorescences), which goes along with the fruiting season. The other alternative would be to use 'pinnatu' instead of fresh fruit pulp. It is also possible to use the fresh pulp with coconut sweet toddy or with sugar-cane molasses and palmyrah molasses which are byproducts of the sugar industry.

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THE FRAME FACTOR — AN APPROACH TO SPECIAL RELATIVITY: *A REVIEW*

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ABSTRACT This paper approaches the transformation rules for field quantities in Classical Field theory by starting with an 'a priori' conservation law concerning numbers which amounts to the divergence theorem in non relativistic physics. A frame factor is then introduced to obtain suitable candidates for Lorentz — covariant 4 — vectors. The frame factor is determined by requirements of the particular field theory concerned.

Introduction

The consequences of the Special Theory of Relativity have become well known since the theory was first put forward by Einstein in 1905. Since that time different people who have thought about the theory have come up with various ways of approaching the theory. This latter exercise is a quest for clarity - to make the theory more intuitively self-evident. Indeed Karl Popper (1963) has pointed out that intuition is a product of expectations, and we are referring here to the expectations of a person with a basic grasp of modern Physics. Even here an approach which one person may find satisfying may not be quite satisfying to another. One may mention here the problem of instrumentalism (Popper, 1975). Some would demand that definition of Physical concepts be accompanied by instrumental means of verification or measurement. While notions such as simultaenity of events in an observer's frame and the length of a moving rod can be defined purely theoretically, some writers take great pains to describe how these can in principle be verified or defined by a judicious deployment of time pieces and signalling devices. Einstien began as an instrumentalist and later changed his stance (Popper, 1975).

The present paper presents an approach which the author has hitherto not come accross. We begin with an a priori intuition about space and time in the spirit of Kant (Korner, 1974). This assumes that matter takes the form of a population of discrete particles. Then given a motion of particle matter and a closed surface in any reference frame, the rate of decrease of population within the surface is equal to the rate at which the population crosses the surface boundary. (This principle can be given a rigorous topological formulation.) We take off from here with the aid of Lorentzian Kinematics.

Preliminaries :

We begin with the statement of some results from Lorentzian Kinematics (Panofsky & Phillips, 1962). Take two observer frames $\Sigma = OXYZ$ and $\Sigma' = O'X'Y'Z'$ which coinside at time $t=t'=O$ and where Σ' moves with uniform velocity v along the x - axis of Σ. Then for any event which takes place at (x,y,z,t) in Σ, the, corresponding co-ordinate in Σ' are given by (x',y',z',t') where $X' = Y(x - vt)$, $y' = y$

$z' = z$, $t' = Y(t - \frac{vx}{c^2})$ - (1)

where $Y = (1 - v^2/c^2)^{-\frac{1}{2}}$

The reverse transform is given by $x = Y(x' + vt')$,.., $t = Y(t' + \frac{vx'}{c^2})$

Writing (x^1,x^2,x^3,x^4) for (x,y,z,ct) and $(x^{1'},x^{2'},x^{3'},x^{4'})$ for (x',y',z',ct') we can write these in tensor form as $x^{i'} = L^i_j x^j$ and -(2)

$x^j = M^j_i x^{i'}$. L and $M = L^{-1}$ can be written in matrix form as

$$L = \begin{Bmatrix} Y & 0 & 0 & -\beta Y \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -\beta Y & 0 & 0 & 1 \end{Bmatrix}, \quad M = \begin{Bmatrix} Y & 0 & 0 & Y\beta \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ \beta Y & 0 & 0 & Y \end{Bmatrix}, \quad \beta = \frac{v}{c} \qquad -(3)$$

These are derived from the two postulates of Einstien using 'thought' (gedanken) experiments. The two postulates are :

1. The laws of physics have the same form when expressed in any observer frame - that is to say they are frame invariant.
2. The speed of light is a constant in all frames independently of the motion of the source.

Further consequences of the Lorentz transform are:

a) The dilation of time: If $\Delta t'$ is the time interval between two events at the same point (x',y',z') in Σ', the time interval Δt between the two events as it appears to an observer stationary in Σ is given by $\Delta t = Y \Delta t' = (1 - v^2/c^2)^{-\frac{1}{2}} \Delta t'$.

b) Contraction of length in the direction of motion : If L' is the length of a rod stationary in Σ' and parallel to O'X', the length L as it appears to Σ is given by $L = Y^{-1} L' = (1 - v^2/c^2)^{\frac{1}{2}} L'$. Length measurements perpendicular to O'X' will remain the same.

c) Means an abandonment of the newtonian concept of a universal time.

See Ref. 1 → 4.

Tensors. The Lorentzian metric g is a bilinear form on two 4 - vectors with $g(x,y) = g_{ij} x^i y^j$, where $g_{ij} = 0$ for $i \neq j$, $g_{ii} = -1$ for $1 \geq i \geq 3$ and $g_{44} = +1$. Hence $g(x,y) = -x^1y^1 - x^2y^2 - x^3y^3 + x^4y^4$.

A 1-form α will as usual denote a linear function on 4-vectors, and will be determined by its 4 components (a_1,a_2,a_3,a_4), so that $\alpha(x)=a_i x^i$.

We shall say that a 1-form β and a vector y are physically equivalent if $\beta_i=g_{ij}y^j$. In standard terminology we say that β is the contravariant equivalent of y.

A 4-vector u is said to be Lorentz-covariant if with the configuration Σ,Σ' above, u & u' are the vectors as they appear to observers O & O' respectively, then $u^{i'}=L^i_j u^i$ - i. e. they satisfy the Lorentz transform rule. Similarly a 1-form is said to be Lorentz contravariant if α,α' satisfy $a'_j=M^i_j a_i$.

A mixed tensor $T^{i_1\ldots i_k}_{j_1\ldots j_l}$ is said to be Lorentz-convariant if T,T' as the tensor is seen by Σ,Σ' satisfies

$$T^{p_1\ldots p_k}_{q_1\ldots q_l} = L^{p_1}_{i_1}\ldots L^{p_k}_{i_k} M^{j_1}_{q_1}\ldots M^{j_l}_{q_l} T^{i_1\ldots i_k}_{j_1\ldots j_l}$$

By the standard rules of partial differentiation we see from (1) that

$$\frac{\partial}{\partial x^1}=\gamma\left(\frac{\partial}{\partial x_1'}-\frac{v}{c}\frac{\partial}{\partial ct'}\right),\quad \frac{\partial}{\partial x^2}=\frac{\partial}{\partial x^{2'}},\quad \frac{\partial}{\partial x^3}=\frac{\partial}{\partial x^{3'}},\quad \frac{\partial}{\partial ct}=\gamma\left(\frac{\partial}{\partial ct'}-\frac{v}{c}\frac{\partial}{\partial x^{1'}}\right)$$

Thus $\frac{\partial}{\partial x^i}=L^j_i\frac{\partial}{\partial x^{j'}}$, and $\frac{\partial}{\partial x^{j'}}=M^i_j\frac{\partial}{\partial x^i}$

If $x_i=g_{ij}x^j$ is the contravariant equivalent of x, then $\frac{\partial}{\partial x_{i'}}=L^i_j\frac{\partial}{\partial x_j}$

It follows that $\frac{\partial}{\partial x_i}$ is Lorentz-covariant and $\frac{\partial}{\partial x^i}$ Lorentz-contravariant.

Lemma: Let $T^{i_1\ldots i_k}_{j_1\ldots j_l}$; $k,l\geq 1$, be a mixed Lorentz convariant tensor.

The tensor $S^{i_1\ldots i_k}_{j_1\ldots j_{l-1}}=T^{i_1\ldots i_k}_{j_1\ldots j_{l-1}p}$ obtained by contraction is also Lorentz-covariant. In particular if a^i, b_i are Lorentz covariant and contravariant respectively, then a^ib_i is invariant.

Proof: We prove that $a^ib_i=a^{i'}b_i'$.

$a^{i'}b_i' = (L^i_j a^j)(M^k_i b_k)= L^i_j M^k_i a^j b_k = \delta^k_j a^j b_k$ since $M=L^{-1}$ $= a^jb_j$.

In particular if $ds = dx^i$ denotes a space-time increment,

$ds^2 = dx^i dx_i$ is invariant.

If x_i represent the space-time co-ordinates of a particle moving with velocity v and dt_0 represents a time increment in the frame of the particle then $dt^2 = (1 - v^2/c^2)^{-1}\ dt_0^2$.

The laws of Physics

From the foregoing discussion and Einstien's first postulate it is a fair surmise that the laws of Physics take the form of identities of the form

$T^{i_1 \ldots i_k}_{j_1 \ldots J_1} = 0$, where T is a Lorentz covariant tensor in space-time, for it follows from (4) that $T=0$ if and only if $T'=0$.

The generalised conservation principle :

In this section we shall assume that matter is composed of almost infinitesimally small discrete particles as is the practice in Chemistry. In a flow of matter, we shall denote by $\eta(x^i)$ the flow (rate) at x^i. That is at x^i $|\ \eta\ |$ is the number of particles per second crossing a unit area nomal to η. Let σ denote the population density of matter.

Taking a small stationary volume v bounded by surface S, the rate of increase of population inside v = - the rate at which the population crosses S.

Hence $\int_S \eta dS + \frac{\partial}{\partial t}\int_v \sigma\ dv = 0$. Dividing by $|\ v\ |$ the volume of v and making $|\ v\ | \to 0$, we have $\nabla . \eta + \frac{\partial \sigma}{\partial t} = 0$ in any frame — (5).

We now introduce the notion of the measure of a particle. What we mean by measure depends on the case of interest. In Electrodynamics for instance measure may refer to the charge carried by the particle. In particle dynamics measure may refer to mass.

By Einstein's first postulate physical properties of a particle in a reference frame are independent of the origin and orientation. Thus measure of a particle in particular is a function of the scalar parameters of motion of the particle. If U is the velocity of the particle the measure will be a function of terms such a $|\ \underset{\sim}{U}\ |$, $|\ \dot{\underset{\sim}{U}}\ |$, $\underset{\sim}{U}.\dot{\underset{\sim}{U}}$, $|\ \ddot{\underset{\sim}{U}}\ |$, etc. We observe from equation (8) where the measure occurs explicitly and from the fact that the Lorentz transform between two frames contains only the instantaneous relative velocity between the two frames, that we may eliminate from measure all terms except $|\ \underset{\sim}{U}\ |$. We thus write f(U) for the measure of a particle, Here $U = |\ \underset{\sim}{U}\ |$.

Let p refer to the measure density in the given frame. Then $p = f(U)\delta$ and $\eta = \delta \underset{\sim}{U} = \frac{p}{f(U)} \underset{\sim}{U}$. Put $J = pU$ = rate of flow measure. Thus $\eta = \frac{J}{F(U)}$

Subtituting in (5) we have $\nabla \cdot \frac{J}{f(U)} + \frac{\partial}{\partial t} \frac{p}{f(U)} = 0$ — (6).

We shall call f(U) the frame factor. Thus (6) represents a generalised conservation principle valid in any frame.

Now define a 4-vector J^i by $(J^1, J^2, J^3, J^4) = (\frac{1}{c} \frac{J}{f(U)}, \frac{p}{f(U)})$.

Thus (6) becomes $\frac{\partial J^i}{\partial x^i} = 0$ — (7).

We have seen that $\frac{\partial}{\partial x^i} = L^j_i \frac{\partial}{\partial x^{j'}}$.

(7) becomes $L^j_i \frac{\partial}{\partial x^{j'}} J^i = 0 = \frac{\partial}{\partial x^{j'}} (L^j_i J^i)$

$= \frac{\partial}{\partial x^{j'}} J^{j'}$ as (7) is frame independent.

J^i can be any 4-vector field with restriction $\frac{\partial J^i}{\partial x^i} = 0$. By writing the transformation J^i to $J^{i'}$ in the form $J^{i'} = F_i(J^1, J^2, J^3, J^4)$ where functions F_i , $i = 1, . , 4$ are independent of J and noting that $J^{i'} \to J^i$ as $v \to 0$, we see without much difficulty that

$$J^{i'} = L^i_p J^p \qquad \text{— (8)}$$

[See Appendix 1]

It follows that J^i is Lorentz-covariant.

In standard texts this same results is obtained by starting with the Lorentz-covariant 4-velocity $\frac{dx^i}{ds}$, where $c^2 ds^2 = dx^i dx_i$. See [1].

This frame factor f(U) is now determined by the Physical requirements of the case under consideration. We shall consider two cases.

Case 1. Dynamics (Landau and Lifshitz, 1976; Kompaneyets, 1961) :

The motion of a particle, as a generalisation of physical experience, is governed by the principle of least action.

Action S on a particle is an integral with respect to time, and this has the form $S = \int_{t_1}^{t_2} L dt$, where L is the Lagrangian. For a particle moving freely, this

integral must not depend on our choice of a reference system and must be invariant under Lorentz transformation.

The only integral of this kind has the form $S = -a \int_a^b ds$.

Thus $S = -\int_{t_1}^{t^2} \propto \sqrt{(1 - \frac{v^2}{c^2})} dt$. Hence $L = -\propto \sqrt{(1 - v^2/c^2.)}$

We define the mass of a free particle to be $\frac{\partial L}{\partial (v^2)} = \frac{1}{2} \frac{a}{c^2} (1 - \frac{v^2}{c^2})^{-\frac{1}{2}} = m$.

For $v = 0$, we obtain the rest mass $m_o = \frac{1}{2} \frac{a}{c^2}$.

Thus $m = m_o (1 - v^2/c^2)^{-\frac{1}{2}}$ and $\frac{f(v)}{f(0)} = (1 - v^2/c^2)^{-\frac{1}{2}}$.

At this point we note that our present definition of mass has come a long way from the instrumental concept using a spring balance. The definition here is a matter of chioce. In further development of covariant laws of mechanics it will be seen that our concept of mass preserves some of the Newtonian properties while carrying additional ramifications such as identification of mass with energy.

Case 2. Electrodynamics :

If we postulate that the electric charge of a particle is independent of its motion — i. e. invariant, this makes f a constant function.

Thus $(\frac{1}{c} J, \rho)$ where J is the current density and ρ the charge density becomes a Lorentz-covariant 4-vector.

Alternatively we may start with the axiom $\frac{\partial J^i}{\partial x^i} = 0$ where $J^i = (\frac{1}{c} J, \rho)$.

Then $\nabla \cdot J + \frac{\partial \rho}{\partial t} = 0 = \nabla \cdot J/f(U) + \frac{\partial}{\partial t} \rho / f(U) = \frac{1}{f(U)} (\nabla \cdot J + \frac{\partial \rho}{\partial t}) + J \nabla \cdot \frac{1}{f(U)} + \rho \frac{\partial}{\partial t} (\frac{1}{f(U)})$.

This tells us that f(U) is constant.

Note : We see that the measurements of mass and electric charge follow two different rules. This choice as has been pointed out is up to a point arbitrary. One consideration important in this choice is to try and maintain the equations of Physics in their pre-relativistic forms.

The standard procedure followed in obtaining relativistic equations of Physics, as was pointed out at the end of section 1 is to extend the classical equations of Physics so that the result becomes an equality between Lorentz-covariant tensors. Thus the Newtonian laws of conservation of momentum and conservation of mass before and after a collision take the form

$$P^i_1 = P^i_2 \qquad \text{— (9).}$$

p^i here denotes the covariant 4 momentum (cmu, mc^2). The three momentum still retains the classical form mu except that the mass m is now not constant and has the form $m=m_o(1-u^2/c^2)^{-\frac{1}{2}}$.

$p_1^4=p_2^4$ modifies the conservation of mass into a law of conservation of energy.

We see in the appendix that the postulate of taking charge to be invariant leads to Maxwell's equations in their pre-relativistic form

As far as physical reality in concerned, our Mathematical efforts are in part inspired fiction. We may never be certain that these are in fact true of reality. Testing them means devising experiments in an attempt to falsify them. If they defy attempts at falsification we may treat them as working conjectures.

It is worth pointing out that our notions of mass and electric charge have gone beyond simple instrumental definitions. To find such now may have to be both complicated and indirect. See (Popper, 1975).

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Appendix 1

From equation (7) in the main paper we have

$$\frac{\partial}{\partial x^{j'}}(L^j_i\ J^i)=0=\frac{\partial}{\partial x^{j'}}(J^{j'}) \qquad -(1)$$

We also have $J^i \rightarrow I^i$ as $u \rightarrow 0$ and J^i is a vector field with the only restriction that $\frac{\partial J^i}{\partial x_i}=0$ in any frame.

We prove from this that $J^{i'}=L^i_j\ J^i$ -(3)

We first prove a lemma from which the result will easily follow.

Lemma: Let J^i be any 4-vector field with the restriction $\frac{\partial J^i}{\partial x^i} = 0$.

Let F^i, $i=1,...,4$ be a set of functions dependent on u but independent of J^i such that $\frac{\partial F^i}{\partial X^i}(J^1,J^2,J^3,J^4)=0$, and

$\lim_{u\to 0} F^i(J^1,J^2,J^3,J^4) = J^i$. Then $F^i(J^1,..,J^4) = J^i$ for all u.

Proof: We have $\frac{\partial F^i}{\partial J^j}\frac{\partial J^j}{\partial X^i}=0$.

Putting $\frac{\partial J^4}{\partial X^4} = -\sum_{i=1}^{3}\frac{\partial J^i}{\partial X^i}=0$.

$$\sum_{i=1}^{3}\left(\frac{\partial F^i}{\partial J^i} - \frac{\partial F^4}{\partial J^4}\right)\frac{\partial J^i}{\partial X^i} + \sum_{i\neq j}\frac{\partial F^i}{\partial J^j}\frac{\partial J^j}{\partial X^i} = 0. \qquad -(3)$$

Since (3) does not contain $\frac{\partial J^4}{\partial X^4}$, the quantities $\frac{\partial J^j}{\partial X^i}$ occurring in (3) can be considered independent of each other.

This leaves the only possibility.

$\frac{\partial F^i}{\partial J^j}=0$ for $i\neq j$ and $\frac{\partial F^i}{\partial J^i} = \frac{\partial F^j}{\partial J^j}$ for all i, j.

Th s we have $F^i = \alpha J^i + \beta^i$. $i=1,...,4$.

$\lim_{u\to 0} F^i(J^1,..., J^4) = J^i$ gives us $\alpha=1$ and $\beta^i=0$. $i=1,...,4$.

(2) easily follows from the lemma.

This is seen from the fact that J^i are functions of $J^{1'}, ...,J^{4'}$ (depending also on u). We may thus write $L^i_j J^j = F^i(J^{1'},...,J^{4'})$. Then use (1) and the Lemma to deduce that $J^{i'} = L^i_j J^j$.

The advantage of the method given here is that in seeking out Lorentz covariant 4-vectors we may not always have directly available some related covariant 4-vector on which we can build—as the covariant 4 velocity $\frac{dx^i}{ds}$ in the ease of particle motion.

We give an application for the case of the retarded definitions of A^i in Electrodynamics. Here $(cA,\phi)=A^i$.

We have $A^i(r,t)=\frac{1}{4\pi\varepsilon_0}\int_V \frac{J^i\left(r^1,t-\frac{|r-r^1|}{c}\right)}{|r-r^1|}\,dv^1$ & $\frac{\partial J^i}{\partial X^i}=\frac{1}{c}\left(\nabla\cdot j+\frac{\partial \rho}{\partial t}\right)=0$

Here $J^i=\left(\frac{j}{c},P\right)$ the Lorentz-covariant 4-current.

Putting $r^1=r+s$, $A^i(r,t)=\frac{1}{4\pi\varepsilon_0}\int_V \frac{J^i(r+s,t-s/c)\,dv^1}{s}$

Hence $c\left(\nabla\cdot A+\frac{1}{c^2}\frac{\partial\phi}{\partial t}\right)=\frac{\partial A^i}{\partial X_i}(r,t)=\frac{1}{4\pi\varepsilon_0}\int_V \frac{\frac{\partial J^i}{\partial X^i}(r+s,t-s/c)}{s}$

$$=\frac{1}{4\pi\varepsilon_0}\int_V \frac{\frac{1}{c}\left(\nabla\cdot j+\frac{\partial\rho}{\partial t}\right)(r+s,t-s/c)}{s}\,dv^1=0.$$

Now J^i are independent exeept for the restriction $\frac{\partial J^i}{\partial X^i}=0$.

We may then suppose A^i to be independent except for the corresponding restriction $\frac{\partial A^i}{\partial X^i}=0$.

An application of Lemma 1 tells us that $A^i=(cA,\varnothing)$ is Lorentz-convariant.

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இவ்விதழ் கட்டுரைகளின் சுருக்கங்கள்

பனஞ்சாற்றின் (கள்ளின்) இரசாயனப் பகுப்பு

ஆசிரியர்கள்:
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Vingnanam J. Sci 1: 1—7 (1986)

சுருக்கம் :-

பனையின் (*Borassus flabellifer*) ஆண், பெண் பூந்துணர்களைச் சீவுதலின் மூலம் பெறப்படும் சாறு, இயற்கையாக நொதிப்படைவதால் பனங் '' கள் '' பெறப்படுகிறது, நொதிப்படையாத நிலையில் இச்சாறுனது 10-16% W/V வெல்லத்தை, முக்கியமாக சுக்குரோசு வெல்ல நிலையில் கொண்டுள்ளது. முற்றாக நொதிப்படைந்த பனங்கள்ளில் 5.8 % V/V அற்கஹோல் காணப்பட்டதுடன் அக்கள்ளின் pH பெறுமானம் 3.9 ஆகவும் காணப் பட்டது. இயற்கையாக நொதிப்படைந்த கள்ளில் உள்ள முக்கிய அமிலம் அசற்றிக் அமிலம் எனக் கண்டறியப்பட்டது. முற்றாக நொதிப்படைந்த கள்ளானது 0.5 % W/V அமிலத்தன்மையைக் கொண்டிருந்ததுடன் ஒரு இளீற்றர் கள்ளில் 39.575 mg. விற்றமின் Cயும் காணப்பட்டது. பனங்கள்ளிலிருந்து பெறப்பட்ட வடிதிரவங்கள் வாயு-திரவ நிறப்பதிவியலிற்கு உட்படுத்தப்பட்டு பகுக்கப்பட்டபோது, இந்நொதிப்பினால் உண்டாகும் மிகமுக்கிய வினைபொருள் எதனோல் எனவும் அத்துடன் வேறுபட்ட அளவுகளில் மெதனோல், n - புரோப்பனோல், சமபியூட்டனோல், ஈதைல் அசற்றேற்று, n - ஏமைல் அற்கஹோல் என்பவை காணப்படுகின்றன எனவும் அறியப்பட்டது. இறுதியில் குறிப்பிடப் பட்ட 3 சேர்வைகளும், முக்கியமாக ஈதைல் அசற்றேற்று எனும் எசுத்தர், பகுக்கப் பட்ட எல்லா மாதிரிகளிலும் காணப்பட்டதால், பனங்கள்ளிலிருந்து பெறப்பட்ட வடி திரவங்களுக்கேயுரித்தான தனித்துவமான மணத்திற்கு இச்சேர்வைகளே காரணமாக உள்ளன எனக் கருதலாம்.

NILAPARVATA LUGENS இன் உயிரியல் பற்றிய அவதானங்கள்

ஆசிரியர்கள்::
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Vingnanam J. Sci. 1 : 8—13 (1986)

சுருக்கம்:

T.N. 1. என்னும் நெல் இனத்தில் வளர்க்கப்பட்ட *Nilaparvata lugens* இன் உயிரியல் பற்றிய படிப்புகள் மேற்கொள்ளப்பட்டன. முட்டைகளின் நீளம் 0.84 m.m., அகலம் 0.16 m.m. ஆகவும், macropterous வகை நிறைவுடலி ஆணின் நீளம் 2.9 m.m., அகலம் 1.1 m.m. பெண்ணின் நீளம் 3.7 m.m. அகலம் 1.2 m.m. brachypterous நிறைவுடலி ஆணின் நீளம் 2.9 m.m.அகலம் 1.0 m.m.பெண்ணின் நீளம் 3.7 m.m.அகலம் 1.1.m.m. முட்டைகளின் அடைகாக்கும் காலத்தின் இடைப்பெறுமானம் 9.6 நாட்கள் macropterous நிறைவுடலி ஆணின் வாழ்வுக் காலம் 13.2 நாட்களாகவும், பெண்ணில் 16.4 நாட்களாகவும் brachypterous நிறைவுடலி ஆணில் 11.2 நாட்களாகவும் பெண்ணில் 11.6 நாட்களாகவும் காணப்பட்டன. இப்பெறுமானங்கள் யப்பான், பிலிப்பைன்ஸ் ஆகிய நாடுகளில் பெறப்பட்ட முடிபுகளுடன் ஒப்பிடப்பட்டது.

CYRTORHINUS LIVIDIPENNIS இன் உயிரியல் பற்றிய அவதானங்கள்

ஆசிரியர்கள்:
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Vingnanam J. Sci. 1: 14—18 (1986)

சுருக்கம் :-

Cyrtorhinus lividipennis Reuter என்னும் இரைகௌவி பூச்சியின் உயிரியல் நன்கு படிக்கப்பட்டது. முட்டையின் சராசரி நீளம் 0.77 mm ஆகவும், அகலம் 0,20mm ஆகவும், ஓர் ஆண் நிறைவுடலியின் நீளம் 2.88 mm ஆகவும் அகலம் 0.92 mm ஆகவும், பெண் நிறைவுடலி 2.94 mm நீளமாகவும், 1.04 mm அகலமாகவும் காணப்படுகின்றன. முட்டையின் அடைகாக்கும் காலத்தின் இடைப்பெறுமானம் 7.36 நாட்களாகவும், முழுக் குடம்பி விருத்திக்காலம் 11.72 நாட்களாகவும் காணப்படுகின்றன. ஆண் நிறைவுடலியின் வாழ்வுக்காலம் 16.47 நாட்களாகவும், பெண்ணில் 18.33 நாட்களாகவும் உள்ளன. முட்டை இடும் வீதத்தின் இடைப்பெறுமானம் 30.08 முட்டைகள் ஓர் பெண்ணிற்கு என்னும் அடிப்படையிலே காணப்பட்டது. இலங்கையில் இச்சனத்தொகையின் வாழ்வுக்காலம் மற்றும் முட்டை இடும் வீதம் என்பன பிலிப்பைன், தாய்லாந்து இனங்களிற்கும், ஹவாய், இந்தியா இனங்களிற்குமிடையான பெறுமானத்தைக் கொண்டிருந்தன.

எலுமிச்சை (*CITRUS*) தாவரத்தில் காய்ப்பு நோயின் சில தன்மைகள்

ஆசிரியர்கள்:
சோதிசொரூபினி நல்லையா, ஆர். வி. எஸ். சுந்தரேசன்
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Vingnanam J. Sci. 1: 19—25 (1986)

சுருக்கம் :-

எலுமிச்சை தாவரத்தில் *Xanthomonas citri* (Hasse) Dowson எனும் பக்றீரியாவால் ஏற்படுத்தப்படும் தொற்றலில் சம்பந்தப்பட்ட காரணிகளைப் பற்றிய சில அடிப்படைத்தகவல்களைப் பெறுவதற்காக தற்போதைய ஆராய்ச்சி செய்யப்பட்டது. ஏறத்தாள 30°Cயும் சாரீரப்பதன் 100%முமாகவுள்ள காலநிலை தொற்றலை ஏற்படுத்துவதற்கு சிறப்பான நிலைமைகளாக உள்ளன, இந் நோயானது வரட்சியான நிலைமைகளிலும் அதே வேளையில் ஈரலிப்பான நிலைமைகளிலும் உக்கிரமாகக் காணப்படலாம்.

இந் நோய்க்குரிய பக்றீரியாவானது கூடுதலாகக் காயங்களினூடாகவே உட்செல்கின்றது. அத்துடன் சில வேளைகளில் இயற்கையாக அமைந்துள்ள வாயில்களினூடாகவும் இது நடைபெறலாம். ஆய்வு கூடத்தில் பரிசோதனை செய்யும்போது வழமையாகத் தொற்றுதல் ஆனது விருத்தியடைவதற்கு கிருமி புகுத்தலிலிருந்து ஏறக்குறைய ஏழு நாட்கள் எடுக்கின்றது. அதே வேளையில் இயற்கையாகத் தோட்டத்தில் வளரும் தாவரத்திற்கு கிருமி புகுத்தப்பட்டபோது தொற்றுதல் விருத்தியடைவதற்கு ஏறக்குறைய பதினெட்டு நாட்கள்வரை எடுக்கின்றது.

ஆய்வுகூடத்தில் வளரும் பக்றீரியாவுக்கு Chloramphenicol,Tetracycline ஆகிய நுண்ணுயிர்க்கொல்விகளைப் பிரயோகிக்கும்போது இவை 100ppm செறிவிலேயே பக்றீரியாவினுடைய வளர்ச்சியைக் குறைக்கின்றது. Antracol, Streptomycin, Copper Sandoz 1000ppm செறிவிலேயே வளர்ச்சியைத் தடை செய்கின்றன.

தாவரத்திலிருந்து தனிப்படுத்தப்பட்ட இலைகளுக்கு நேரடியாக இரசாயனப் பொருட்களைப் பிரயோகிக்கும்போது Tetracycline 100 ppm செறிவிலேயே நோய்க்குரிய அறிகுறி விருத்தியடைவதைத் தடுக்கின்றது. அதே நேரத்தில் Chloramphenicol, Streptomycin, Copper Sandoz, Cupravit ஆகியவை 1000ppm செறிவில் தான் நோய்க்குரிய அறிகுறிகள் தோன்றுவதைத் தடுக்கும்.

கத்தரிக்காயில் ஏற்படும் பழஅழுகலின் சில தன்மைகள்

ஆசிரியர்கள்:
ஆர். வி. எஸ். சுந்தரேசன், சிவனேஸ்வரி கனகசுந்தரம்
(தாவரவியல் துறை, யாழ் பல்கலைக்கழகம்.)
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(உயிரியல்துறை, கயானா பல்கலைக்கழகம், கயானா).

Vingnanam J. Sci. 1 : 26—28 (1986)

சுருக்கம்:

கத்தரிக்காயில் ஏற்படும் பழஅழுகல் நோயின் தீவிரமும், பரவும் பற்றி ஆராய்ச்சி செய்யப்பட்டது. இத்தகைய கத்தரிக் காயுடன் சம்பந்தப்பட்ட பதினெரு பங்கசு இனங்கள் தனிப்படுத்தப்பட்டு அடையாளங் காணப்பட்டன. இந்தப் பங்கசு இனங்களில் 5 இனங்கள் மட்டுமே பழ அழுகலை உண்டாக்குவதற்குப் பொறுப்பானவையாக இருக்கின்றன என இந்நோயைப் பற்றிய படிப்பு தெரியப்படுத்தியது. அவையாவன *Phoma spp, Botryodiplodia theobromae, Rhizopus spp., Absidia spp.* வும் *Fusarium spp.* வும். இவற்றால் உண்டாக்கப்பட்ட முக்கியமான நோய்க்குரிய அறிகுறிகள் பதிவு செய்யப்பட்டன.

யாழ்ப்பாண குடிநீரின் தன்மை

ஆசிரியர்:
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Vingnanam J. Sci,1. 29—39 (1986)

சுருக்கம் :

யாழ்ப்பாண குடாநாட்டின் நிலநீரின் உவர்த்தன்மை, கடினத்தன்மை என்பவற்றினது செறிவின் போக்கானது காலத்தொடர் பகுப்பு, உத்தேச செய்முறை ஆய்வு ஆகிய புள்ளிவிபர நுட்பங்களினால் ஆராயப்பட்டுள்ளது. இவ் ஆய்வுக்கு தெரிவுசெய்யப்பட்ட பிரதேசமானது வட பிரதேச நீர்வளச்சபையினால் பாகுபடுத்தப்பட்ட யாழ்குடாநாட்டின் மேற்குப்பாகமாகும். இப்பிரதேசத்தில் பெறக்கூடிய தொடர்ச்சியான தரவினைக் கருத்திற் கொண்டு 68 மாதிரிகள் ஆய்விற்காகத் தெரிவுசெய்யப்பட்டுள்ளன. இத்தரவுகள் 1979-ம் ஆண்டு ஜனவரி மாதத்திலிருந்து 1984 ஜூன் மாதம்வரை மாதத்தரவுகளாகப் பெறப்பட்டுள்ளன. இவ்வாய்வினிருந்து உவர்த்தன்மையானது பொதுவாக காலப்போக்கில் அதிகரிக்கும் என்பதையும் கடினத்தன்மை இதுபோல் மாறுதுள்ளமையும் காட்டப்பட்டுள்ளது.

பனம் நாற்றுக்கள் வளர்ப்பதற்கு ஒரு நவீன முறை

ஆசிரியர்கள்:
சோ. கந்தையா, கி. மகேந்திரன்
(தாவரவியல் துறை, யாழ் பல்கலைக்கழகம், இலங்கை)
Vingnanam J. Sci. 1 : 40–43 (1986)

சுருக்கம்:

இயற்கை முறைமூலம் பனம் விதைகளை, இலகுவில் கையாளக்கூடிய சிறிய கொள்கலன்களில் முளைக்க வைப்பது முளைவளர்ச்சிக்கு இடையூற்றைக் கொடுப்பதால் கன்று தாக்கமுறும். விதை அகற்றப்பட்ட பனங்கிழங்குகளைக் குளிரூட்டப்பட்ட சூழல் வெப்பநிலையிலிருந்து 10°C அளவிற்கும் அதிகமான, 35°C அடிப்படை வெப்பநிலையைக் கொடுப்பதன் மூலமும் கிழங்குகள் வேர்விடும் தன்மையைப் பெறுகின்றன. இதனைத் தொடர்ந்து வேர்விட்ட கிழங்குகள் சிறிய பொலித்தீன் பைகளில் வளர்க்கப்படலாம்.

பனம் பழ சாற்றிலிருந்து மதுசாரம்

ஆசிரியர்கள்:
க. தெய்வேந்திரராஜா, R. குமுதினி கிறிஸ்ரோபர்
(தாவரவியல் துறை, யாழ்ப்பாணப் பல்கலைக் கழகம்)
Vingnanam J. Sc. 1: 44–46 (1986)

சுருக்கம்:

பாணித்தன்மையுடைய பனம்பழ சாறுனது நேரடியாக மதுசார தயாரிப்பில் பயன்படுத்தப்பட முடியாததாயினும் பனியிலிருந்து பெறப்படுகின்ற வேறொரு இனிப்புக் கரைசலான பனம் சாற்றுடன் (கருப்பணி) இதனைச் சேர்த்து நொதித்தலை மேற்கொள்ளலாம். ஐதாக்கப்பட்ட பனம் சாற்றையும் பழச்சாற்றையும் நொதிக்க வைப்பதன்மூலம் பொருளாதார ரீதியாக அநேகமான வெல்லத்தை மதுசாரமாக மாற்றலாம். 6 பகுதி கருப்பனி 4 பகுதி நீர் 2 பகுதி பழச்சாறு கொண்ட ஊடகத்தை நொதிக்க வைத்ததன் மூலம் 5.15% v/v மதுசாரம் பெறப்பட்டது. பழச்சாற்றுக்குப் பதிலாக ஒரு பழச்சாற்றுப் பெறுதியான ''பஞ்சட்டை'' சேர்த்ததன் மூலம் கூடிய அளவு மதுசாரம் பெறப்பட்டது.

THE FRAME FACTOR — AN APPROACH TO SPECIAL RELATIVITY: A REVIEW

ஆசிரியர்:
M. R. R. Hoole
(கணித புவியியல் துறை யாழ்ப்பாணப் பல்கலைக்கழகம்)
Vingnanam J. Sci. 1 ; 47 — 55 (1986)

சுருக்கம்:

இப்பத்திரம், தொடர்பியல் சாரா பௌதிகத்திலுள்ள விரிதோற்றத்திற்கு இட்டுச் செல்லும், எண்கள் சம்பந்தமான காப்பு விதியுடன் ஆரம்பித்து, பழைய புலக் கொள்கையிலுள்ள புலக்கணியங்களுக்கு ஒரு உருமாற்று நெறியை (*Transfomation rule*) தெருங்குகிறது.

காப்பு விதியின் பின், உலொன்ரன்சு - இனை மாறிலி - காவிகளுக்கு பொருத்தமான ஒரு கணியத்தை (வல்துவை) காணுமுகமாக சட்டம் தொடர்பான ஒரு காரணி (*Frame factor*) அறிமுகப்படுத்தப்பட்டுள்ளது. இந்தச் சட்டக் காரணி, அது சம்மந்தப்பட்ட, குறிப்பிட்ட புலக் கொள்கைக்கு தேவையானவற்றால் நிர்ணயிக்கப்படும்.

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